New Vanguard

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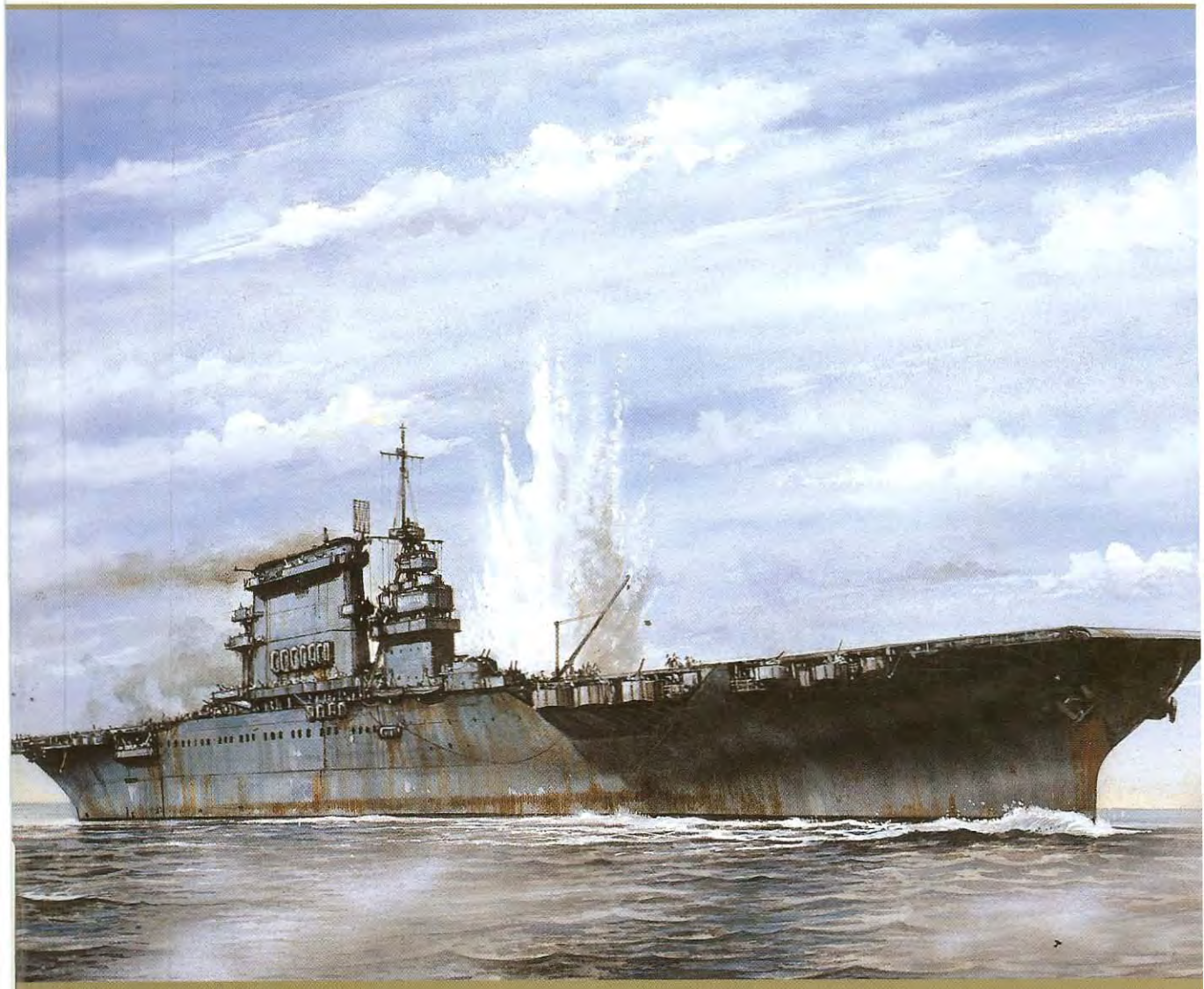
US Navy Aircraft Carriers 1922–45

Prewar classes



Mark Stille • Illustrated by Tony Bryan

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US NAVY AIRCRAFT CARRIERS 1922–45 PREWAR CLASSES

ORIGINS

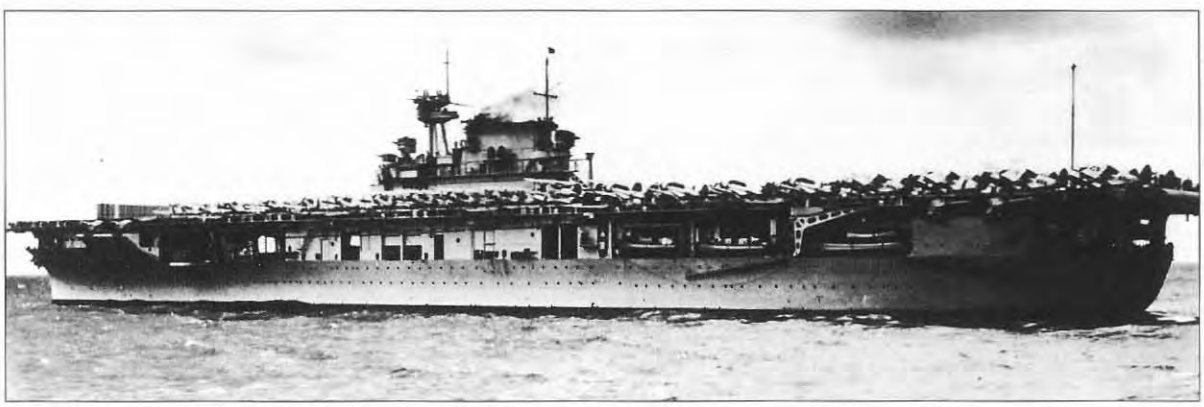
In 1910, the US Navy became the first to launch an aircraft from a ship when Eugene Ely piloted a floatplane off a wooden platform built on the cruiser USS *Birmingham*. In 1911, Ely became the first aviator to recover an aircraft aboard a warship when he landed on the armored cruiser *Pennsylvania* anchored in San Francisco Bay. Despite the fact that this landing had all the elements of what was to become standard procedure for landings aboard carriers, the US Navy did not follow up this initial lead in carrier technology. Instead, seaplanes were pursued because of their economy and the fact that they did not impede the operations of the launching ship's guns. Experiments were begun into mounting catapults aboard large warships to support the use of seaplanes, but none were in service when the First World War began.

During the war, work continued on catapults. Successful catapult trials seemed to indicate that a major investment in aircraft carriers was unnecessary. The US entry into the First World War in 1917 caught the US Navy without a single carrier or ship dedicated to operating aircraft. By the end of the war, the Royal Navy had clearly established a lead in naval aviation and the US Navy had yet to begin the construction of a single carrier. Finally, fears of falling further behind the Royal Navy (which was already operating several carriers) and the realization that air supremacy was an essential part of modern naval operations compelled Congress to fund the conversion of a collier into an aircraft carrier in July 1919.

The most famous of the prewar carriers was undoubtedly *Enterprise*. Here she is shown with her air group spotted on deck, en route to Pearl Harbor in October 1939.

Early US Navy carrier doctrine

The initial role of US Navy carriers was to support the battle fleet. The battleship was still viewed after the First World War as the arbiter of naval



The importance of striking the enemy's carriers first, an essential element in prewar US Navy doctrine, was evidenced during the pivotal battle of Midway. Here *Yorktown*, with her strike group spotted on deck, prepares to attack the Japanese carrier force on June 4, 1942.

power and the carrier's role was to provide reconnaissance and spotting for the battle fleet while denying those advantages to the enemy. Use of aircraft to spot at long ranges exposed enemy ships to plunging fire against their weaker deck armor rather than their much stronger vertical armor. Such an advantage was viewed as decisive by the battleship admirals. Carriers were also expected to protect the air space over their own fleet, thus denying the enemy the advantages of long-range spotting and scouting.

Another important mission for carrier aircraft in the aftermath of the First World War was antisubmarine patrol. Patrolling aircraft from carriers could keep enemy submarines submerged and, against a fast-moving force, a submerged diesel-electric submarine with a top speed of less than 10 knots was effectively neutralized.

Only gradually did the US Navy develop the carrier's role as an independent offensive platform. The first carrier aircraft were unable to carry torpedoes large enough to cripple or sink a capital ship. Of course, bombs could be carried, but these posed no real threat to ships maneuvering at speed to avoid attack. However, in the 1920s, the offensive capability of carrier aircraft was greatly increased by the development of divebombing, which for the first time allowed maneuvering ships to be struck with some degree of accuracy. Capital ships with heavy deck armor were still immune from attack but carriers, with their unarmored flight decks, had now become very vulnerable.

Reflecting the premise that carriers could not withstand significant damage, US Navy doctrine increasingly separated the carriers from the battle fleet in order that they escape early detection and destruction by the enemy. The primary task of the carrier was now to destroy opposing carriers as soon as possible, thus preventing their own destruction, and to set the stage for intensive attack on the enemy battle fleet. To maximize the carrier's striking power, standard US Navy doctrine called for the launch of an entire air group at one launch. In order that an entire "deck load" strike be launched quickly, it was necessary to have the entire strike spotted on the flight deck. Once flight operations had begun, it was imperative to keep elevator movements to a minimum, so strike operations were essentially limited to those aircraft spotted on the flight deck.

The continuing requirement to quickly generate maximum offensive power against enemy carriers affected US Navy carrier design. This meant that the developments and techniques necessary to quickly launch a full deck of aircraft were paramount. Open, unarmored hangars and the

The US Navy's prewar fears of the vulnerability of its carriers was largely accurate during at least the first year of the war. This photo shows the effect of a Japanese divebombing attack on *Yorktown* at Midway. A 550lb bomb penetrated the flight deck and exploded inside the stack uptakes with the result being the intense black smoke seen here.

provision of catapults facilitated the quick launch of large numbers of aircraft. Doctrine called for most of the carrier's aircraft to be parked on the flight deck with the hangar deck used for aircraft maintenance and storage. This practice and the design of US carriers meant that they operated larger air groups than their foreign contemporaries. The primacy of the needs of the aviators and the restrictions of the 1922 Washington Naval Treaty drove all prewar carrier designs.

During flight operations, the carrier would turn into the wind and steam at full speed to launch aircraft. Aircraft could be launched either by means of a take-off roll or by catapult. As aircraft became heavier, the use of catapults became more important. Effective use of catapults allowed the quicker launch of a large strike and for heavier loads to be carried, but their widespread use did not occur until late in the Second World War. When a strike was being launched, the heaviest aircraft were spotted aft so that they would have a longer take-off roll. Lighter aircraft were spotted forward, often as far forward as amidships. Prewar doctrine also called for the launching of scout bombers from the hangar deck by use of catapults. This would not require any dislocation of the strike aircraft parked on deck.

When recovering aboard ship, aircraft returned over the stern where they would be caught by one of several arresting wires running across the aft portion of the carrier. Barriers would be rigged between the landing area and the bow of the ship where aircraft were parked after landing. All US prewar carriers had provision for recovering aircraft over the bow in case the aft part of the ship was damaged. For this contingency, there was a back-up set of arresting wires installed in the forward part of the ship.

Japanese torpedo planes proved to be the most potent weapon against US carriers in the early war period. Here a Japanese B5N torpedo plane (still carrying its weapon) breaks through *Hornet*'s screen in an attempt to torpedo the carrier during the battle of Santa Cruz in October 1942.

The prewar US Navy carrier air group

In the prewar period, and into the Second World War itself, the standard US carrier air group had four squadrons. One scouting squadron with the primary mission of finding enemy carriers was embarked. Spotting aircraft disappeared from the air group in the late 1920s, this mission being taken over by cruiser and battleship floatplanes. There was a single squadron of fighters. Strike aircraft included a squadron of dive bombers and a squadron of heavy strike aircraft that could be employed as torpedo or level bombers. Evolving tactics and aircraft technology resulted in adjustments to the air group through the 1930s, but the basic structure was little changed going into the Second World War. By 1938, the standard prewar carrier air group had four squadrons of some 18 aircraft each, with another three in reserve. The dive bomber squadron was retained, but the scout squadron was now equipped with scout bombers instead of the earlier spotting aircraft types. When more modern aircraft entered service, like the Douglas SBD Dauntless, both the dive bomber and scout squadrons were equipped with identical aircraft. Later, during the war, the scout squadrons were disbanded and combined with the divebombing squadron. The fighter squadron was retained and grew in size as the war unfolded. A fourth squadron remained equipped with torpedo bombers that could also operate as level bombers. This organization was standard for the larger carriers of the *Lexington* and *Yorktown* classes; the smaller *Ranger* and *Wasp* were designed without provision to support a torpedo squadron so, in its place, a second fighter squadron was embarked.

Prewar carriers each had a permanently assigned air group. Each of the four squadrons was numbered after the hull number of the ship it was assigned to. For example, *Lexington*'s fighter squadron was numbered VF-2, her dive bombers VB-2, her scout bombers VS-2 and her torpedo squadron VT-2. After July 1938, air groups were known by the name of the ship. Thus, the squadrons listed above comprised the *Lexington* Air Group. By mid-1942, the entire air group was numbered to

***Hornet* in February 1942, showing the changing composition of the US Navy air groups during the early war period. The biplane aircraft spotted on deck are Curtiss SBC-4 dive bombers that would soon be replaced by Douglas SBD Dauntlesses. Also evident are F4F Wildcats and TBD-1 Devastator torpedo planes.**

match its parent ship's hull number. With few exceptions, the permanence of the squadrons within an air group generally lasted through the battle of Midway. After that, due to carrier losses or squadron exhaustion, carriers could have a mix of squadrons from two or three air groups.

Fleet carriers maintained this basic four-squadron structure for most of the war with some fluctuation in the numbers of aircraft assigned to each squadron. By the late war period, in the face of a large-scale threat from suicide aircraft, carrier air groups were reorganized to emphasize air defense and the ability to neutralize enemy aircraft on their airfields before they could threaten the carriers. In the summer of 1945, air groups had large fighter squadrons (36 aircraft), a fighter-bomber squadron (another 36 aircraft), and much smaller dive bomber and torpedo squadrons totaling some 30 aircraft. The only prewar carriers that survived into the late-war period were *Enterprise* and *Saratoga*; both had been converted into night carriers. As such, they carried smaller air groups of some 60 aircraft in only two squadrons.

***Enterprise*'s torpedo squadron (VT-6) shown spotted on the flight deck on June 4, 1942. Of the squadron's 14 aircraft sent against the Japanese carrier force at Midway, only four survived. This was the Devastator's final combat operation.**

DEVELOPMENT

Prewar naval aircraft

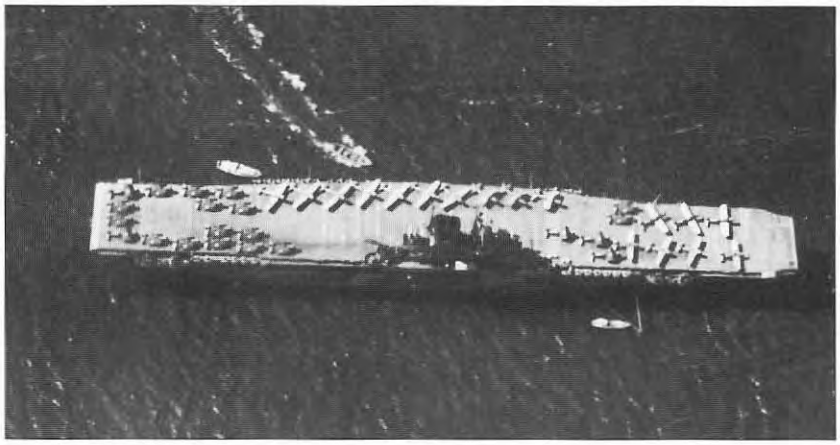
By December 1941, the Navy had made the transition from a wide variety of biplane aircraft to a force almost entirely composed of monoplane aircraft. The mix of aircraft ranged from modern to obsolescent.

Fighter squadrons were equipped with the modern Grumman F4F-3 Wildcat (176 on hand) and the F4F-3A (61 on hand). The newest variant of the Wildcat, the six-gun F4F-4, was just coming into service, but the older Brewster F2A-3 Buffalo still remained in service in a few squadrons. In the Pacific, Wildcats equipped fighter squadrons VF-3 and VF-6, while VF-2 still had Buffalos. In the Atlantic, VF-41 and 42 were assigned to *Ranger*, VF-5 to *Yorktown*, and VF-71 and 72 to *Wasp*. The just-forming VF-8 was headed to *Hornet*.

In 1937, torpedo squadrons received their first monoplane torpedo aircraft, the Douglas TBD Devastator. For its day, it was a modern aircraft, but by 1941 it was already obsolescent. Five squadrons were in service at the beginning of the war: VT-2, 3, 5, 6, and 8. The Devastator's replacement, the Grumman TBF, was already on order, and after the disastrous performance of the Devastator at Midway, all remaining aircraft were retired from combat service.

The main striking power of the air group was its dive bombers. In 1941, 14 Navy squadrons were equipped with dive bombers, some designated scouting (VS) and some bombing (VB). During the war, this designation ceased to have any meaning as both types were equipped with the same type of aircraft and both conducted the same type of missions, so the two squadrons were combined into one. In December 1941, VB-2, VS-2, VB-3, VS-3, VB-5, VS-5, VB-6, and VS-6 were equipped with the Douglas SBD-2/3 Dauntless. VS-41 and 42, assigned to *Ranger*, still had the older SB2U-1/2 Vought Vindicator as well as VS-71 and 72 on *Wasp*. *Hornet*'s working up VB-8 and VS-8 had the older Curtiss SBC-4 biplane.

Lexington **on October 14, 1941 with her air group. She is carrying F2A Buffalo fighters forward, SBD Dauntlesses amidships, and TBD-1 Devastators aft. The ship is wearing a Measure 1 camouflage scheme with a Measure 5 false bow wave.**



This June 1942 view of *Wasp* shows much of her air group on deck. Aircraft present include F4F Wildcat fighters and SB2U Vindicator dive bombers. Not until her transfer to the Pacific would *Wasp* receive the more modern SBD Dauntless dive bombers and add a torpedo squadron to her air group.

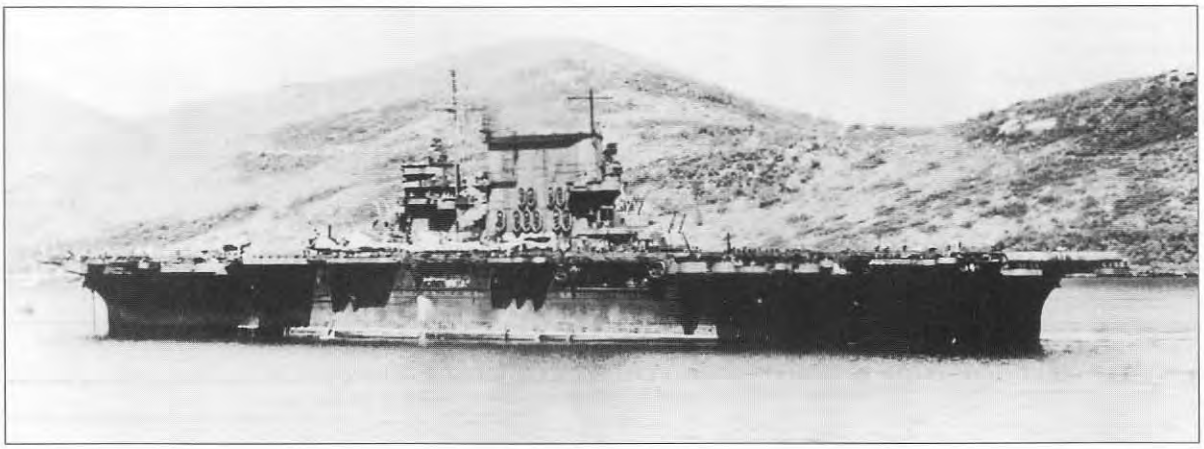
Weapons

Of course a carrier's principal armament is its aircraft, but US carriers carried a number of weapons designed to defend them against air attack. For long-range air defense, all carriers from *Lexington* onwards carried 5in guns. Originally, these were the 5in/25 guns with a maximum range of 14,500yd. Beginning with *Yorktown*, and later on all surviving ships except *Ranger*, the excellent 5in/38 gun was fitted. This weapon was probably the outstanding dual-purpose naval gun of the Second World War. Compared to the older 5in gun, its increased length gave it a greater velocity and hence greater range. However, the gun was also notable for its accuracy, barrel life, and, most importantly, rate of fire. It remained in service well beyond the war. On most prewar carriers, it was mounted on the corners of the flight deck. To keep the loss of flight deck space to a minimum, the guns were fitted on sponsons. Except on *Saratoga*, which was large enough to handle a twin gun mount version of the 5in/38, all prewar carriers received the powered pedestal-type single mount, usually fitted in groups of two. Later in the war, the introduction of the proximity fuse round greatly increased the effectiveness of this weapon.

SPECIFICATIONS FOR THE 5IN/38-CAL. GUN

Bore	5in
Shell weight	55lb
Muzzle velocity	2,600ft/sec
Maximum range	18,200yd
Rate of fire	15–20 rounds/min

Fire control for the 5in/38 was provided by the Mark 33 Director. This was a third-generation director that could provide target solutions for higher speed targets at greater degrees of angularity. Two Mark 33s were fitted per ship. As carriers conducted their first extensive wartime overhaul, the Mark 33 Directors were fitted with the Mark 4 fire control radar. It was very successful in service but was ineffective against low-flying targets. The Mark 37 was a considerable advance over the Mark 33. *Hornet* received two when completed and later *Enterprise* and *Saratoga* received their Mark 37s in place of the Mark 33. The Mark 4 radar was later replaced by the Mark 12/22 fire control radars; these addressed



***Saratoga* after her first wartime modifications. Note the 5in/38 turrets that have replaced the 8in gunhouses. A CXAM-1 radar can be seen on the forward part of the stack. Mark 37 Directors are located on top of the island and aft of the stack.**

a problem with confusion caused by the returning signal as well as addressing the low-flying target problem.

As divebombing came to be recognized as a threat, carriers received short-range and intermediate-range antiaircraft protection. Originally, close-in protection was provided by the provision of relatively large numbers of .50-cal. machine guns. These were the water-cooled version of the US Army's standard heavy machine gun placed on a naval mount. Fire control was accomplished by use of a ring sight and tracer rounds. Despite its high rate of fire of over 700 rounds per minute, the inherent inaccuracy of the weapon, combined with a small shell weight of under two ounces, made it ineffective. It remained in service, though, until replaced by the 20mm gun.

Beginning in 1942, the Swiss-designed 20mm Oerlikon gun replaced the .50-cal. machine guns. Like the weapon it replaced, it was intended for last-ditch defense against aircraft and was fitted as a single mount. The 20mm gun was air-cooled. It required no external power source and was relatively lightweight, so it was introduced in large numbers and bolted anywhere with a free arc of fire. Later, a twin mount was introduced and some were fitted on *Enterprise*. By war's end, it was clear that the 20mm lacked the hitting power required to break up kamikazes and it was replaced, where space permitted, by the heavier 40mm gun. The Mark 14 electric gunsight could be used as a director for the 20mm, which greatly increased its effectiveness.

SPECIFICATIONS FOR THE 20MM OERLIKON GUN

Bore	.7874in
Shell weight	.271lb
Muzzle velocity	2,740ft/sec
Maximum range	4,800yd
Rate of fire	450 rounds/min

To provide intermediate-range protection, carriers were fitted with the 1.1in machine cannon. This weapon was four-barreled and water-cooled. Rate of fire was 140 rounds per minute firing a one-pound projectile. Fire control was accomplished locally or with the help of a director. In service, the weapon was heartily disliked by its crews as it was difficult to maintain

***Enterprise*, in March 1942 at Pearl Harbor. Additional 20mm guns have been placed on her bow to augment those on the gallery deck. The large CXAM-1 radar is evident on her foremast.**

and tended to jam in action. Replacing the ill-fated 1.1in mount was one of the better antiaircraft weapons of the war. This was an adaptation of the Swedish-designed Bofors gun. In US Navy service, it was used in single, double, or quadruple mounts. For ships with sufficient space, the quadruple mount was preferred. Each gun was capable of firing 160 two-pound projectiles per minute. However, with each gun being hand-loaded, the maximum rate of fire was never achieved. Fire control was provided by the Mark 44 and 51 Directors. Late in the war, even the 40mm gun proved insufficient to stop kamikazes.

SPECIFICATIONS FOR THE 40MM BOFORS GUN	
Bore	1.575in
Shell weight	1.985lb
Muzzle velocity	2,890ft/sec
Maximum range	11,000yd
Rate of fire	160 rounds/min

Radar

A critical development during the prewar years that had a great impact on US carrier doctrine and tactics was the development of radar. The combination of radar, the Combat Information Center (or CIC), and the resulting central direction of the ship's combat air patrol greatly improved the survivability of US Navy carriers. During the early part of the war, as demonstrated at the Coral Sea and Midway and as late as the battle of Santa Cruz in October 1942, carriers remained vulnerable to air attack. In response to this threat, the size of fighter squadrons continued to grow (up from 18 to 27 at Midway, and further increased to 36 during the Guadalcanal campaign), but their effective control was key. Work continued on the effective use of radar and fighter direction and by 1944 this combination was developed enough to provide a significant degree of protection against conventional attack. The development of the Japanese kamikaze aircraft late in the war forced the refinement of

***Enterprise* in December 1943 after operations in the Marshall Islands. In this mid-war appearance, she exhibits a greatly strengthened 20mm and 40mm antiaircraft fit together with an upgraded electronics fit including a CXAM-1 and an SM radar mounted on the tripod mast, an SC radar on the stack, and two Mark 37 Directors with Mark 4 radar.**

fighter direction tactics and the further increase in the number of fighters in an air group.

The US Navy's radar program resulted in the delivery of 20 CXAM radar sets in 1940. These were fitted aboard all six carriers then in service. *Yorktown* was the first carrier fitted with radar, receiving her CXAM in July 1940. CXAM was an air search radar that used a very large mattress-like antenna. Increases in power, and therefore detection ranges, led to the CXAM-1 radar. With an accuracy of 200yd, it was capable of detecting a large aircraft flying at 10,000ft at 70 nautical miles or a small aircraft at 50 nautical miles. The second-generation SC radar had essentially the same electronics as the CXAM-1 with the addition of an integral Identification Friend or Foe system and limited altitude detection capabilities, but with a smaller antenna. With an accuracy of 100yd, it was capable of detecting a large aircraft flying at 10,000ft at 80 nautical miles or a small aircraft at 40 nautical miles. The range of the SC radar proved disappointing. Prewar carriers that survived into the mid and late war period received a number of radar upgrades. The CXAM-1 radar was replaced by the SK radar with a range of 100 nautical miles. The SK combined the electronics of the SC-2 with a CXAM-sized antenna. The height finding SM radar was fitted for fighter direction and could detect a large aircraft at 50 nautical miles and provide an elevation within 500ft.

USS *LANGLEY* (CV-1)

Design and construction

The first American carrier was a conversion from a slow collier, USS *Jupiter*. Unable to procure funding from Congress for a modern carrier, the US Navy had to settle on a conversion to provide it with its first carrier in order that experimentation with naval aviation from ships at sea could begin.

Design work and funding for the ship was completed in 1919 and in March 1920 conversion work began. When completed in March 1922, the ship was commissioned as USS *Langley* and given the designation CV-1 (the designation CV representing a fleet carrier and 1 being the

After being damaged by Japanese bombing, *Langley* was scuttled by two torpedoes from the destroyer USS *Whipple*. Much of *Langley*'s crew was later lost when their rescue ship was sunk.

first ship of this designation). It was never intended that *Langley* be anything more than a platform for experimentation.

The conversion was fairly simple, with a wooden flight deck being built over a framework of beams and girders. The sides below the flight deck were not covered, giving the ship her nickname of the "Covered Wagon." Navigation was accomplished from a small bridge under the flight deck in the forward part of the ship – there was no island located on the flight deck. The flush deck made disposal of the ship's smoke a problem. After an awkward initial arrangement, the ship was provided with a pair of hinged funnels on the port side. The turbo-electric machinery of the collier was retained, but her top speed of only 14 knots meant that she was too slow to operate with any part of the fleet.

With regard to aircraft handling facilities, *Langley* bore no resemblance to later fleet carriers. The ship retained its six coal holds; one was now used to store aviation gasoline, one contained the machinery for the aircraft elevator, and the other four provided aircraft storage. The aircraft were stored disassembled and were lifted out of the holds by means of a three-ton gantry crane under the flight deck that moved over the four aircraft holds. There was no hangar deck. After removal from their hold, aircraft were assembled on the former collier upper deck. After assembly, the aircraft were moved to the flight deck by means of a single elevator. When originally commissioned, *Langley* had provision for operating floatplanes from cruisers and battleships. As a depot ship for floatplanes, she had two cranes for lifting them from the water and two catapults for launching them. These catapults were removed in 1928 when it was decided to remove spotting aircraft from carrier air groups. Despite her relatively small size, *Langley* usually embarked 30 aircraft, this being increased to as many as 42 on occasion. However, her awkward handling facilities made any rapid launch and recovery of more than a few aircraft impossible.

Armament

When completed, *Langley* was provided with four 5in guns meant to provide some measure of protection from enemy surface attack. As a carrier, she never had her armament upgraded.

Service modifications

Since she was not a front-line unit, *Langley* was little modified during service. In 1928, the flight-deck-mounted catapults were removed. In 1936, *Langley* was removed from service as an aircraft carrier. For the last

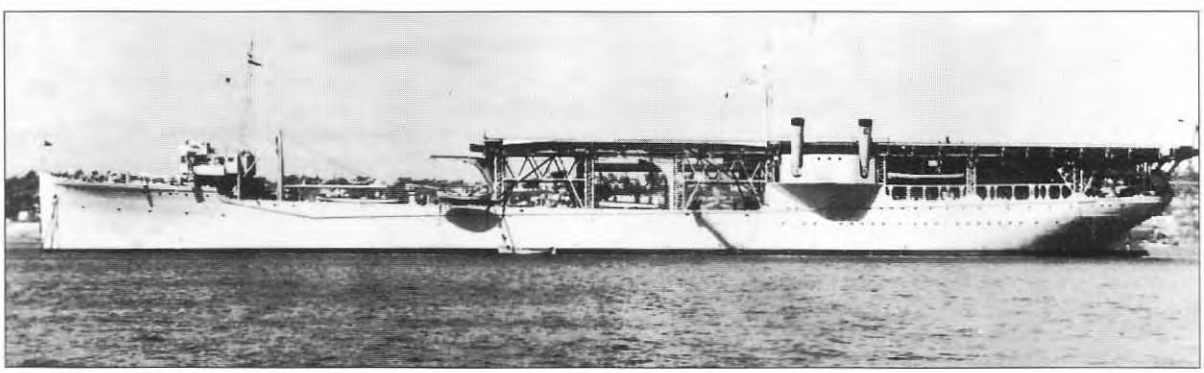
***Langley* c.1932 with the majority of her air group on deck. The system of girders supporting the flight deck is evident as are the two small port side stacks. The port side 5in guns can also be seen forward and aft just under the flight deck.**

years of her life, she served as a seaplane tender. Between 1936 and 1937, conversion to her new role took place and resulted in the removal of the forward 41 percent of the flight deck. Before her loss, she was provided with additional antiaircraft protection in the form of four 3in/50 guns fitted on the old flight deck and four .50-cal. machine guns around the bridge.

Operational history

The introduction of *Langley* into fleet service in 1924 finally allowed the US Navy to gain an appreciation of the value of carrier aviation. From the very beginning, even *Langley* carried a large number of aircraft for her size, a practice continued with every other prewar carrier. Exercises from *Langley* developed air combat and divebombing tactics. Employed during fleet exercises in the 1920s, *Langley*'s air group reinforced the importance of scouting and fleet air defense. She also demonstrated the offensive potential of carriers that could carry and launch large numbers of bombers. Despite her second-line status, *Langley* was retained as a carrier until 1936, probably because, having been declared an experimental ship, she did not count against the US carrier tonnage allocation from the Washington Naval Treaty. When the US entered the Second World War, *Langley* was already into her third life, as a seaplane tender. Employed as an

***Langley* after conversion to a seaplane tender in 1937. With the addition of four flight deck 3in antiaircraft guns added in the Philippines, this is how she appeared at the time of her loss.**



***Saratoga* under way in Puget Sound in September 1944. The new SK radar is fitted on the foremast, with the SM radar taking its place in the forward edge of the stack. Note the dramatic increase in her antiaircraft fit on a number of sponsons built along the level of the hangar deck. The ship is wearing a Measure 32/Design 11a camouflage scheme designed for her unique profile.**

aircraft transport ferrying 32 badly needed ready-to-fly P-40 fighter aircraft to the Dutch East Indies, *Langley* was discovered and bombed by long-range aircraft of the Imperial Japanese Navy on February 27, 1942. After five direct bomb hits and a number of near misses, the aged ship was scuttled by escorting destroyers.

USS (UNITED STATES SHIP) *LANGLEY*

Displacement: 11,500 tons
Dimensions:
- Length 542ft
- Beam 66ft
- Draft 24ft

Maximum speed: 14kt
Radius: 12,260nm
Crew: 350

Assessment

Even though slow, unable to carry a large air group, and possessing awkward aircraft-handling arrangements, *Langley* was a true pioneer. Until 1928, she was the only carrier in fleet service and was instrumental in demonstrating the potential of carrier aviation to the US Navy. The tactics and technologies tested on *Langley* would lead ultimately to the development of the carrier force that would sweep all before it in the Second World War.

THE *LEXINGTON* CLASS (*LEXINGTON* (CV-2) AND *SARATOGA* (CV-3))

Design and construction

The question of whether the US Navy should build its first fleet carrier from the keel up or use a battle cruiser hull for conversion was solved by the Washington Naval Treaty, which forced the cancellation of all US battle cruisers already under construction or planned. Additionally, the treaty dictated that new carrier construction be limited to 23,000 tons, but an exemption was granted for conversions up to 33,000 tons from existing

The US Navy's first three carriers shown *c.*1930 in Bremerton, Washington. The immense size of the converted battle cruisers *Lexington* and *Saratoga* compared to the experimental *Langley* is striking.

capital ships. Even this figure was insufficient for *Lexington*'s conversion into a carrier, which was saved only by a clause in the treaty that allowed the modernization of existing capital ships (and by extension carriers converted from capital ships) to protect them from air and torpedo attack, with the addition of an extra 3,000 tons. Even so, completion of the ships at the 36,000-ton limit proved difficult.

Conversion of both ships was begun in 1922 and both were launched in 1925. In 1927, when they were commissioned, they became the largest carriers in service and would remain so until the completion of the Japanese *Shinano* in 1944. When completed, both ships gave ample evidence of their battle cruiser ancestry. The battle cruiser hull was carried up to the hangar deck. The hangar deck itself was entirely enclosed within the hull, with the flight deck acting as the main load-bearing deck. This restricted the number of aircraft that could be carried on these large hulls and was in contrast to later fleet carrier designs that featured open hangars and had the hangar deck as the main deck. Also, unusually for a US carrier, the bow and stern of the ship were faired into the hull.

The ships' most noticeable feature was the huge smoke stack on the starboard side, which was located aft and separate from the island. The turbo-electric machinery fitted was the most powerful in the US Navy and provided the ship with a top speed of 34 knots. The island was small and contained gunnery control and navigation facilities.

The aircraft hangar, huge for its day, was actually smaller than in subsequent carriers with only a fraction of *Lexington*'s displacement. This meant that many aircraft had to be permanently parked on the flight deck. The extreme length of the flight deck (880ft) permitted the US Navy's full-deck strike doctrine to be exercised, as the entire original complement of 90 aircraft could be ranged on the flight deck and flown off. As in subsequent fleet carriers, the flight deck was not armored but made of steel with a covering of wood planking. While providing minimal protection against bombs, this type of construction permitted the rapid repair of battle damage and a quick return to flight operations. Two large elevators were provided and a single catapult was fitted on the flight deck.

This 1932 view off Hawaii shows *Lexington*'s profile to full advantage, including the huge stack, the separate small island, and the battle cruiser hull that enclosed the hangar deck.

As on *Langley*, the original system of recovering landing aircraft was by a system of anchored longitudinal wires and weighted transverse wires. By 1931, this system was abandoned and eight arresting wires were installed on the aft portion of the flight deck and provided with hydraulic controls to help stop landing aircraft. This became the norm for all later fleet carriers.

Armament

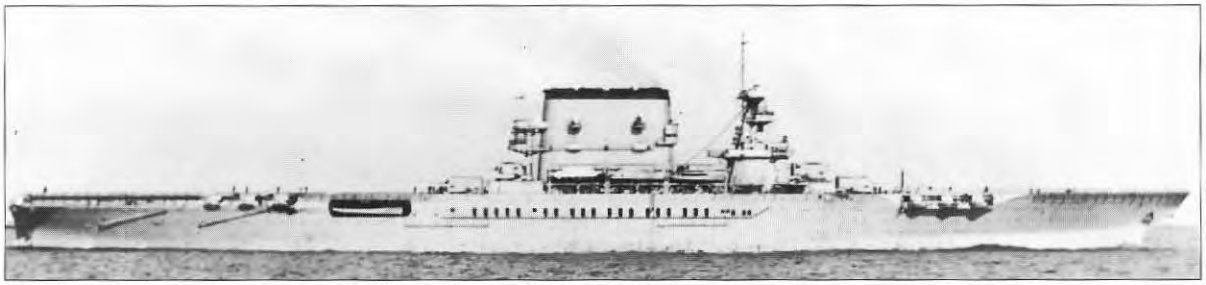
As completed, the *Lexington* class was armed to repel surface as well as air attack, the only class of US fleet carrier so equipped. Eight 8in guns were fitted in four twin gunhouses, two forward of the island and two aft of the stack. The 8in gun was chosen to allow the ships to deal with the fast "treaty" cruisers, which could also be equipped with guns up to 8in. In service, these guns were not effective in their designed purpose since they could not fire across the flight deck without causing blast damage. For antiaircraft protection, 12 single 5in/25 gun mounts were positioned in groups of three on sponsons on the corners of the flight deck.

Service modifications

Before the war, both ships received little in the way of modernization; as the most powerful carriers in the fleet, their absence from service for an extended period could not be tolerated. Initial modifications included the removal of the single catapult in 1934.

Lexington was the more modern of the two sisters before the war as she had had her bow widened in 1936, expanding the size of the flight deck, and in 1940 a CXAM air search radar had been installed on the forward part of the stack.

To counter the growing threat of divebombing, both ships received a large battery of machine guns. These were fitted on the 8in gunhouses, on a gallery around the stack, and on platforms near the 5in guns. The .50-cal. machine guns were recognized as insufficiently powerful to deal with dive bombers so, in 1940, 1.1in quadruple machine cannons were installed. Five of these weapons were fitted, reducing the number of machine guns to 28. The outbreak of war saw the antiaircraft battery further reinforced. *Lexington* had her 8in guns removed in April 1942. When she was sunk the following month at the Coral Sea, she mounted



***Saratoga* just after commissioning in 1928. Early in their careers, the two *Lexingtons* were virtually identical, so a large vertical stripe was added to *Saratoga*'s stack to assist observers in distinguishing her from *Lexington*.**

a total of twelve quadruple 1.1in mounts, 32 20mm guns, and the 28 machine guns. At the same time, *Saratoga* retained her 8in mounts, had nine 1.1in mounts, and 32 20mm guns; all of her machine guns had been removed.

Saratoga did not lose her 8in battery until a yard period following her torpedoing in January 1942. At this time, she received most of the modifications planned prewar but never carried out. This included the provision of a large blister for torpedo defense. All the 8in guns were removed and the antiaircraft battery was reinforced with 16 5in/38 guns – eight in four turrets in place of the 8in gunhouses and eight replacing the 12 5in/25 guns on a two-for-three basis. To save weight, the tripod foremast was replaced by a light pole mast and the stack was lowered. *Saratoga* also had her flight deck widened at the bow and lengthened aft. Other changes included the provision of a pair of Mark 37 5in Directors (with Mark 4 radars), another air search radar (the SC for back-up), and four quadruple 40mm guns in place of the same number of 1.1in mounts (five 1.1in mounts remained) and the fitting of 30 20mm guns.

Saratoga's antiaircraft fit was later increased again following her August 1942 torpedoing. The last of the 1.1in mounts were replaced by 40mm quadruple mounts and an additional 22 20mm mounts were fitted.

A refit from December 1943 to January 1944 brought a further increase in the ship's antiaircraft fit at the request of her commanding officer. In spite of the mounting weight problems, another 14 additional 40mm quad mounts were fitted. Two twin 40mm mounts were also fitted on the port side abeam the island. All but 16 of the 20mm guns were removed. By this time, the ship also had an SK air search radar fitted in place of her old CXAM.

***Lexington* viewed from *Yorktown* on May 8, 1942, the day the two US carriers engaged in history's first carrier battle. The four 8in gunhouses have been removed and replaced with light antiaircraft weapons.**

Another refit later in 1944 saw the provision of an SM fighter-director radar set. This provided the ship with the standard US carrier late-war radar suite of two air search and one fighter-director set. Also in this period, she received two deck-mounted hydraulic catapults to assist in night flight operations. During repairs following heavy damage in February 1945, the small aft elevator was removed and a larger one fitted forward. To alleviate severe overcrowding, much of the after end of the hangar deck was filled with two decks of berthing compartments.

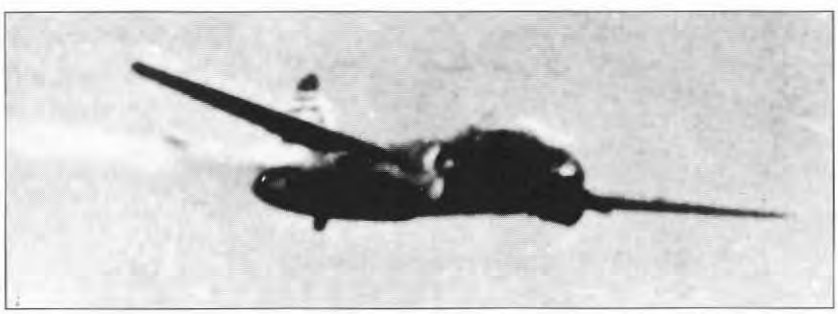
Operational histories

USS *Lexington*

Lexington entered service in 1928 and was joined the same year by her sister ship. Both ships were assigned to the Pacific Fleet where they would spend almost their entire operational lives. Doubts about the utility of these two huge ships were quickly removed. In the Fleet Problem of 1929, the twins demonstrated their ability to operate aircraft in all weather and to launch a large single deck-load strike, the driving imperative of current US carrier tactics. In a series of Fleet Problems in the 1930s, the *Lexingtons* demonstrated a number of tactics that would become standard during the war, including long-range strikes by carrier aircraft, the independent, offensive use of carriers, and the operation of separate carrier task groups, each composed of a carrier and its escorting cruisers and destroyers.

Lexington's actual war service was brief. On December 7, 1941, she was delivering Marine fighter aircraft to Midway Island and thus escaped destruction at Pearl Harbor. After an abortive attempt to relieve Wake Island in December 1941, *Lexington* was dispatched to counter Japanese operations in the South Pacific. Her first combat took place in February 1942 when she was sent to attack Japanese forces at their newly captured base at Rabaul, New Britain. Following her discovery by long-range Japanese aircraft before she could launch her own attack, her fighters and antiaircraft fire destroyed 15 of 17 attacking Japanese bombers. Later, on March 10 while operating with *Yorktown*, *Lexington* launched 52 aircraft to strike Japanese naval forces off Lae and Salamaua, New Guinea, but the results (three transports sunk) were disappointing given that total surprise had been achieved and Japanese air defenses were negligible.

After a short visit to Pearl Harbor, *Lexington* redeployed to the South Pacific to counter a Japanese attack against Port Moresby, New Guinea. Operating again with *Yorktown*, *Lexington* moved into the Coral Sea and prepared to meet the Imperial Navy in the first-ever clash between



***Lexington*'s first combat came on February 20, 1942 during an abortive raid on the Japanese base at Rabaul. Seventeen G4M bombers launched a raid against *Lexington* as she withdrew. Because of the immature state of fighter direction, several survived to drop bombs near the maneuvering *Lexington*, but no hits were scored. This shot shows the group leader's aircraft (note command markings on the horizontal stabilizer) flying down *Lexington*'s port side during an unsuccessful attempt to crash the crippled bomber into the carrier.**

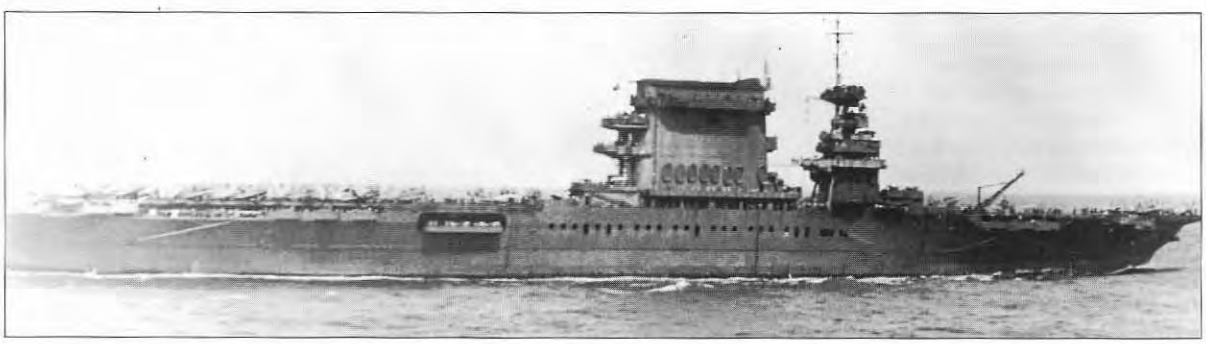
carriers. In a confused action, the two equal sides (the Japanese had deployed two fleet carriers to cover their invasion force) launched strikes on May 7, but failed to strike each other's main carrier forces. However, *Lexington*'s aircraft did sink the Japanese light carrier *Shoho*. On the next day, both sides struck the other's carriers. *Lexington*'s strike of 36 aircraft, combined with 39 from *Yorktown*, pounded the fleet carrier *Shokaku* with three bombs, but the Japanese carrier did not sink. In return, despite the fact that US radar picked up the Japanese strike force at 68 miles and the carriers were defended by 20 fighters and 23 Dauntlesses on anti-torpedo plane patrol, the Japanese attack force of 69 aircraft inflicted heavy damage on *Lexington*, scoring two torpedo hits on her port side and three bomb hits. However, in less than two hours, damage control personnel had extinguished all fires and corrected a seven-degree list. Just as it looked as if *Lexington* would survive, a massive explosion took place, sparked by leaking gas vapors as a result of aviation gas tanks being ruptured from the effects of battle damage. This time the flames could not be controlled and, after a second massive explosion, the ship was abandoned. The *coup de grâce* was delivered by two torpedoes from an escorting destroyer.

USS *Saratoga*

Saratoga was one of only two prewar carriers that saw combat service in the Pacific and survived. The attack on Pearl Harbor saw the ship off the US west coast. She quickly headed west to take part in the aborted relief of Wake Island. On January 11, 1942, near Pearl Harbor, *Saratoga* received her first war damage when she was struck by a single torpedo from submarine I-6. The damage did not threaten to sink the ship, but it did require a return to the west coast for repairs. Repairs and training of a new air group prevented *Saratoga* from taking part in the decisive phase of the battle of Midway.

Saratoga next headed into the South Pacific to support the first US offensive of the war, the invasion of Guadalcanal Island in the Solomons in August 1942. Later in August, *Saratoga* played a key role in the war's third carrier battle, the battle of the Eastern Solomons. Her 36-aircraft strike sank the light carrier *Ryujo*. Because of cloud cover, *Saratoga* escaped the retribution of the Imperial Navy's fleet carriers, with *Enterprise* taking the brunt of the Japanese attack. On August 31, *Saratoga* was again struck by a submarine torpedo, this time from I-26. The attack damaged her turbo-electric propulsion system and, after temporary repairs, the ship headed to Pearl Harbor for permanent repairs. After her return to service,

***Lexington* viewed later on May 8 from heavy cruiser USS *Portland*. This well-known shot is the last taken of *Lexington* in a fully operational condition. The ship is down by the bow, but has recovered her air group. Note the 1.1in guns where the 8in gunhouses were and the platform at the base of the stack for additional 20mm guns. The ship is in a Measure 11 scheme.**



***Saratoga* under way in 1942 with a portion of her air group spotted aft. The ship spent much of the war's first year under repair from torpedo damage. As the world's longest warship, she required time to answer to steering orders and proved an inviting target for Japanese submarines.**

Saratoga remained in the South Pacific until November 1943 providing cover for operations in the Solomons. In November 1943 her aircraft struck the Japanese bastion of Rabaul, damaging several heavy cruisers that had arrived to strike the US beachhead on Bougainville, New Britain.

After another brief refit, *Saratoga* returned to Pearl Harbor in January 1944. Following attacks delivered against Japanese garrisons on several Central Pacific islands, *Saratoga* moved west to join the British Eastern Fleet in the Indian Ocean. Operating with a Royal Navy carrier, she struck the port of Sabang, Sumatra, on April 16. A later raid against Soerabaja, Java, was also successful.

Following operations with the Royal Navy, *Saratoga* returned to the west coast for her second refit of 1944. This prepared her for duty as a night carrier and as such she operated with USS *Ranger* in the area of Pearl Harbor, training pilots in night operations and developing night fighter tactics. In January 1945, *Saratoga* received the call to return to combat operations, joining *Enterprise* to form a night fighter carrier division to support the invasion of Iwo Jima. In the course of these operations, *Saratoga* received her last damage of the war. On February 21, the ship was struck by a total of six bombs in two separate attacks. Despite damage to her flight deck and large fires in the hangar deck, she was able to recover aircraft in three hours. *Saratoga* returned to service in May, following repairs, and resumed her training duties. At the conclusion of the war, *Saratoga* was employed in duties to return servicemen to the US, transporting more than 29,000 personnel, more than any other ship.

By war's end, *Saratoga* was superfluous to requirements and was assigned to Operation *Crossroads* to test the effects of atomic blasts on naval units. The first blast on July 1, 1946 inflicted only minor damage, but a second blast the following day proved fatal. She sank the same day, as damage control efforts were impossible on her radioactive hull.

USS *LEXINGTON*

Displacement: 36,000 tons
Dimensions:
- Length 888ft
- Beam 105ft
- Draft 32ft

Maximum speed: 34kt
Radius: 6,960nm
Crew: 2,122 (prewar), 2,381 (*Saratoga*, 1944)

***Ranger* shown in October 1936. The lightness of her construction is evident. The six small stacks used to vent the ship's smoke are in their cruising position; during flight operations they would be positioned parallel with the hangar deck. The small island is an afterthought as the design originally called for a flush-deck ship.**

Assessment

The *Lexingtons* introduced the fleet carrier concept to the US Navy. In their day they were larger, faster, and carried more aircraft than any other carrier in the world. They were ideal platforms to test the theories of the Navy's aviation advocates during the prewar years and proved without doubt that large carriers were preferable to a number of smaller carriers, a notion that continues in the US Navy until this day. Despite not being based on any experience, their 1920s design was generally successful and the ships were still capable of rendering excellent war service.

USS *RANGER* (CV-4)

Design and construction

Ranger was the first US carrier designed and built as such from the keel up. Following the conversion of the two *Lexingtons*, 69,000 tons remained of the US Navy's allocated carrier tonnage under the Washington Naval Treaty. Many different designs were considered to use this remaining tonnage, but what resulted reflected the US Navy's desire to make full use of its treaty allocation and to maintain numerical parity with the other two carrier powers of the day, the Royal Navy and the Imperial Japanese Navy. The eventual size selected (13,800 tons) was driven by a desire to produce five additional smaller carriers instead of a smaller number of larger carriers. This size was seen as adequate for building a carrier that had sufficient aircraft capacity and handling facilities.

Construction of *Ranger* began in 1931. When commissioned in 1934, she introduced several features that would become common in future US prewar carrier designs, including provision for an island, an open hangar, a gallery deck around the flight deck, and provision for cross-deck catapults mounted on the hangar deck.

Many of *Ranger*'s features were compromised by the requirement to fit the design into 13,800 tons. The narrow hull was provided with no underwater protection and only a single inch of steel on the hangar deck. The internal subdivision was inadequate and the placement of the boiler and machinery rooms meant that a single hit could knock out the

***Ranger* shown on July 6, 1944 in a Measure 33/Design 1a camouflage scheme. Despite the profusion of antiaircraft weaponry and the addition of radar, the ship was never committed to a high-threat area and by this time had already assumed the role of a training carrier.**

ship's entire propulsion system. Adequate space was not available to fit turbo-electric drive, so cruiser-type geared turbines were installed. Maximum speed was an inadequate 29.5 knots. Since the original design did not call for the provision of an island, the smoke from the six boilers was vented up six small stacks, three on each side of the aft hangar. During flight operations, the hinged stacks were rotated to a position parallel with the hangar deck.

Ranger's design was optimized to support the maximum number of aircraft. The hangar deck was actually larger than that of the *Lexington* class. Two elevators were fitted close together nearly amidships in an unusual arrangement driven by the desire to clear space for the hangar deck catapults (although they were never actually fitted). Originally it was planned to complete her with a flush deck to facilitate flight operations, but *Lexington* amply demonstrated the command and control advantages from even a small island, so a small starboard side island was added before completion. This placed *Ranger*'s final tonnage over the envisioned design limit and added to her top weight problems.

Aircraft capacity was designed to be 76 including 36 fighters, 36 scout/dive bombers, and four utility aircraft. At the time of her design, divebombing was seen as the most potent antiship weapon, so no provision was made for torpedo storage and, until later in the war, no torpedo plane squadron was embarked. Also, 40 assembled fuselages could be mounted on the overhead of the hangar deck high enough not to interfere with aircraft movement in the hangar. Even during the war while operating larger aircraft, *Ranger* embarked as many as 72 aircraft; during the North African invasion, she embarked an air group of 54 Wildcats and 18 Dauntlesses.

Armament

When originally completed, eight 5in guns were fitted. The initial configuration of the 5in battery had two of the four forward guns located on the forecastle under the flight deck and two of the aft guns positioned on the hangar deck. This arrangement proved unsatisfactory and was soon replaced by the usual arrangement of four pairs of guns on the corners of the flight deck. Two Mark 33 Directors were placed on the island to service the 5in battery. *Ranger* was among the first US Navy ships fitted with light automatic weapons to defend against divebombing. Initially, 40 .50-cal. machine guns were fitted.

***Yorktown* shown in October 1937 just after her commissioning. Note the forward starboard sponson for two 5in/38 guns.**

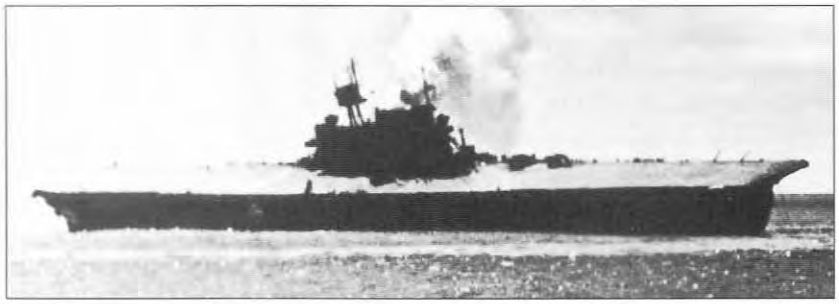
Service modifications

Beginning in September 1941, *Ranger*'s antiaircraft protection was increased. Six 1.1in quadruple mounts were added at the expense of 16 of the original 40 .50-cal. machine guns. A refit following the ship's participation in the North African landings resulted in another augmentation of the ship's antiaircraft battery with six quadruple 40mm mounts replacing the 1.1in mounts and a total of 46 20mm guns being added. Additionally, *Ranger* retained her original battery of eight 5in/25 guns.

By mid-war the ship was heavily overweight and obsolescent. In the fall of 1943, six of the 20mm guns were removed. A comprehensive overhaul that would have provided some degree of underwater protection and the ability to operate modern aircraft was considered in late 1943, but was canceled when it was realized that the work would result in the delayed completion of two *Essex* class carriers. A final refit in May–July 1944 confirmed that *Ranger* was no longer suitable for combat duties. Now she was equipped as a night training carrier: a new flight deck catapult was added and her flight deck strengthened. Facilities to control night fighters were added, including a new SM height-finding radar. To compensate, all eight 5in guns were removed.

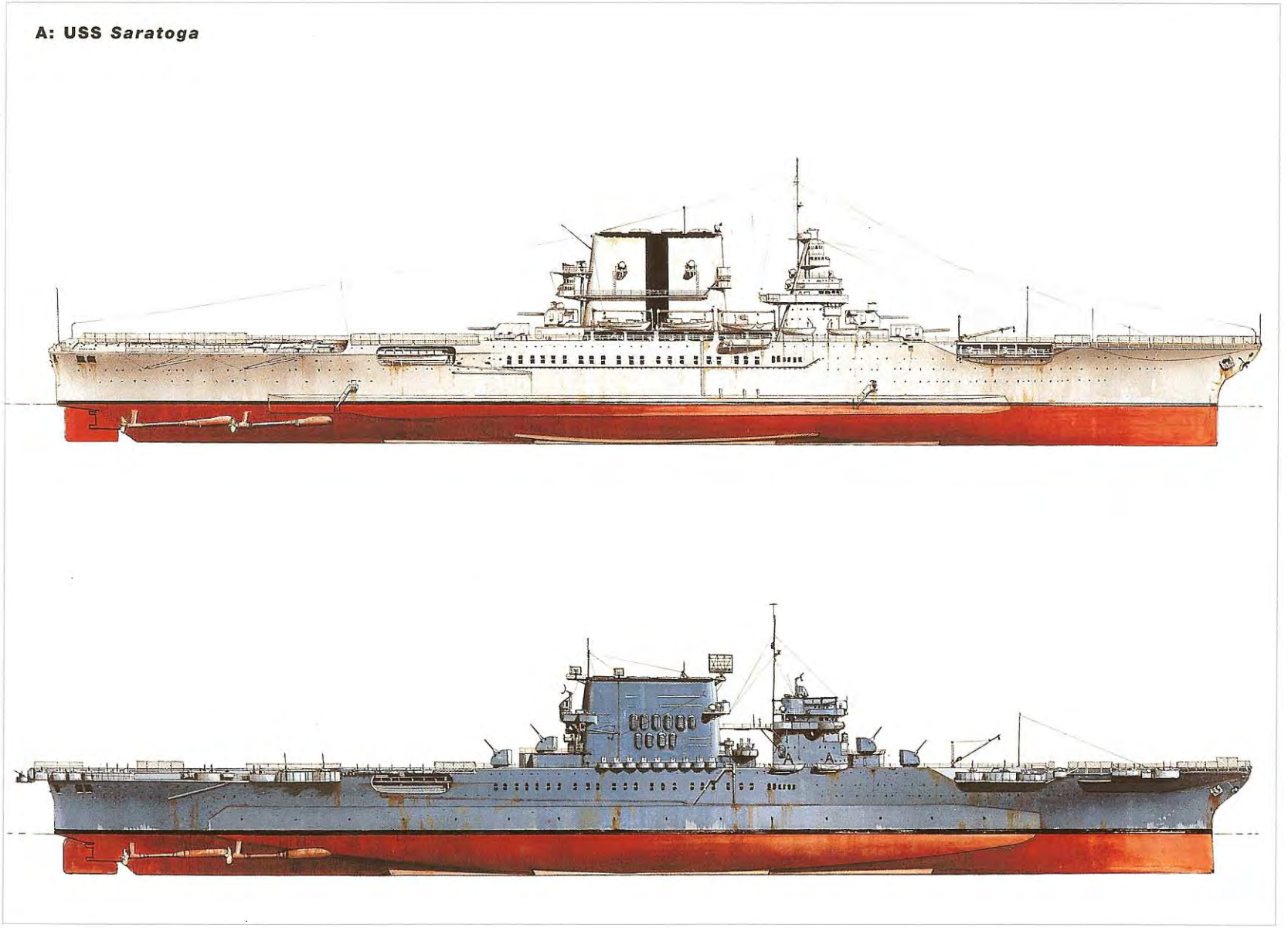
Operational history

After joining the Atlantic Fleet, *Ranger* participated in several annual Fleet Problem exercises beginning in 1935. Early in her career, she exhibited signs of problems in heavy seas. When the US entered the war, *Ranger* was still active in the Atlantic and by May 1942 she was the only fleet carrier not assigned to the Pacific Fleet. Twice during 1942, in April

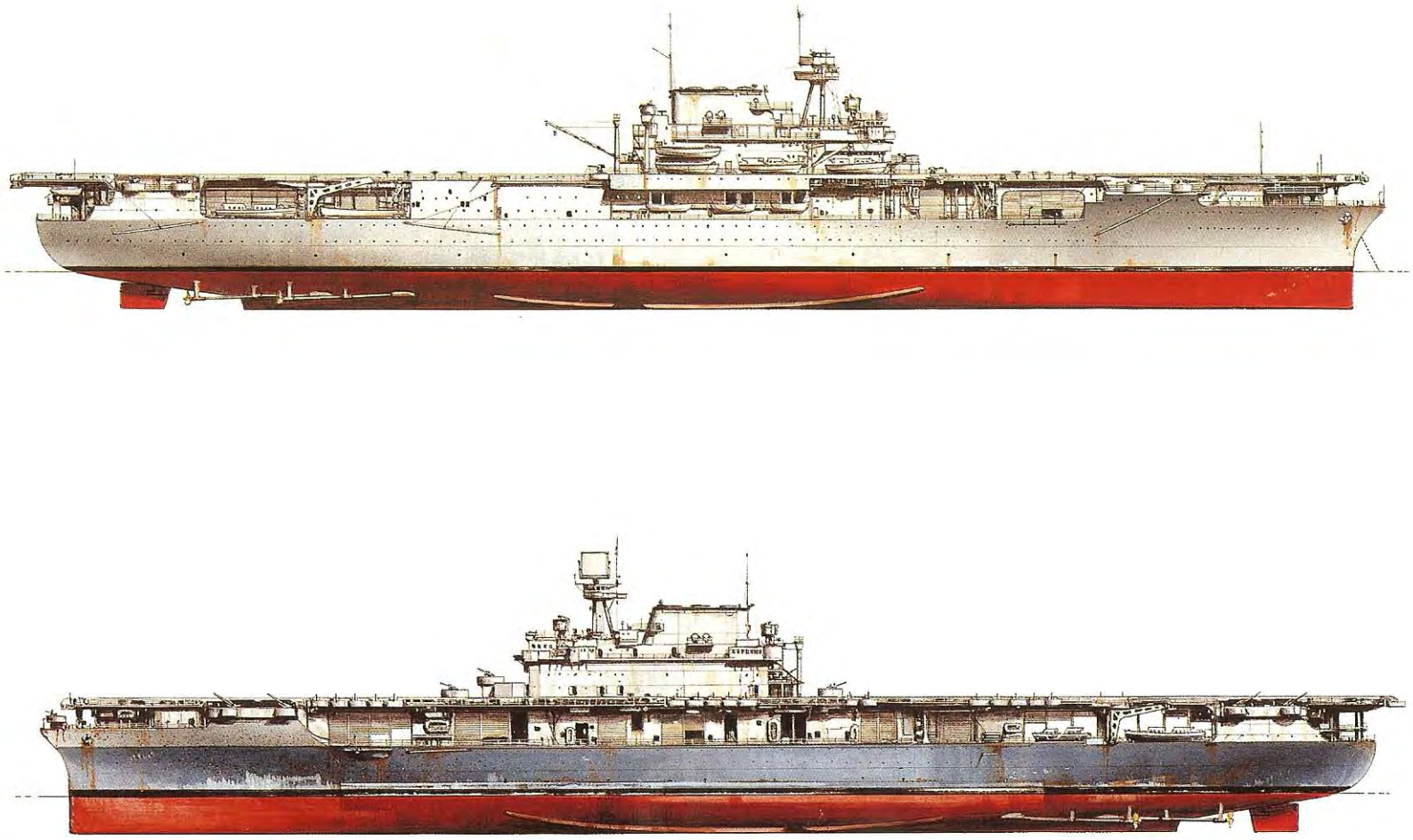


***Yorktown* dead in the water following the attack of *Hiryu*'s torpedo aircraft. Two hits on the ship's port side resulted in a heavy list. Despite the damage, salvage efforts would have succeeded if *Yorktown* had not received two additional submarine-fired torpedoes.**

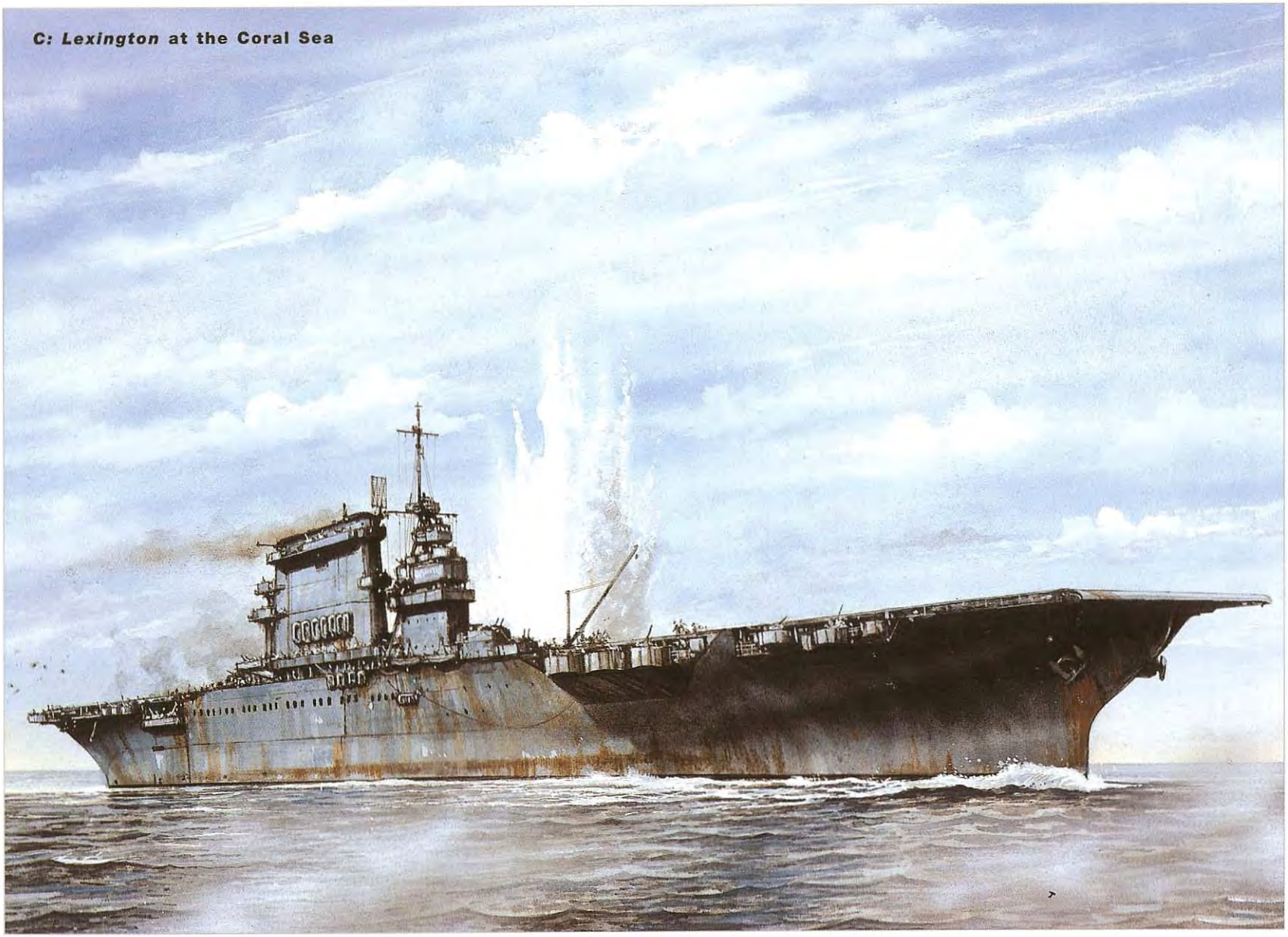
A: USS *Saratoga*



B: The *Yorktown*



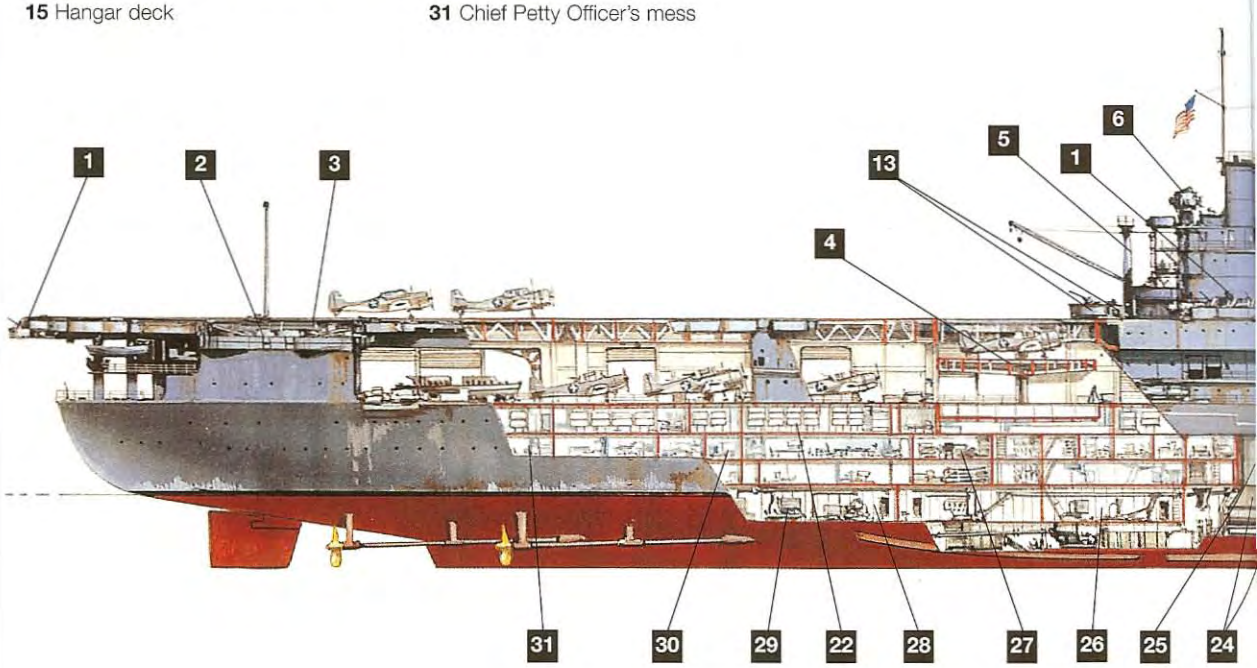
C: *Lexington* at the Coral Sea



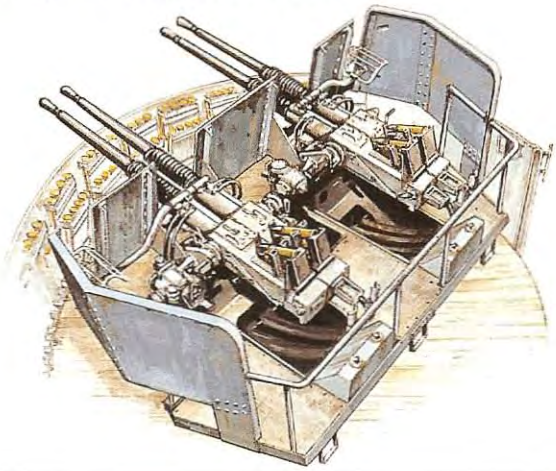
D: USS *ENTERPRISE*, JUNE 1942, AT THE BATTLE OF MIDWAY

KEY

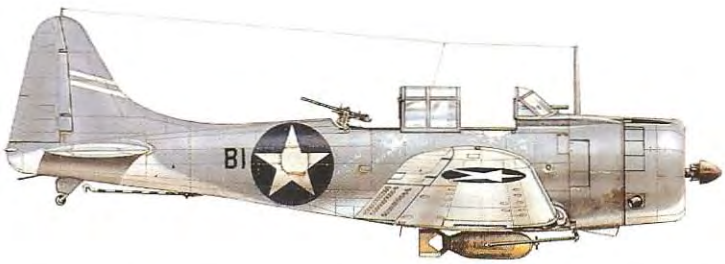
1 20mm Oerlikon guns (many)
2 5in dual purpose guns (4 on the starboard side)
3 Location of aft elevator
4 Location of middle elevator
5 Boat and aircraft cranes
6 Mk 35 Gun Director (2)
7 Squadron ready room (several)
8 Signal bridge
9 CXAM-1 antenna
10 Island
11 Flag bridge
12 Navigation bridge
13 1.1in quadruple antiaircraft guns (4)
14 Gallery deck
15 Hangar deck
16 Roller curtains
17 Location of forward elevator
18 Officer staterooms (many)
19 Ordnance and aviation stores
20 Fuel tanks
21 Officer's wardroom
22 Crew berthing
23 Crew's mess
24 Boiler rooms
25 Boiler room uptakes
26 Machinery room
27 Galley
28 Generator room (2)
29 Evaporator room
30 Sick bay
31 Chief Petty Officer's mess

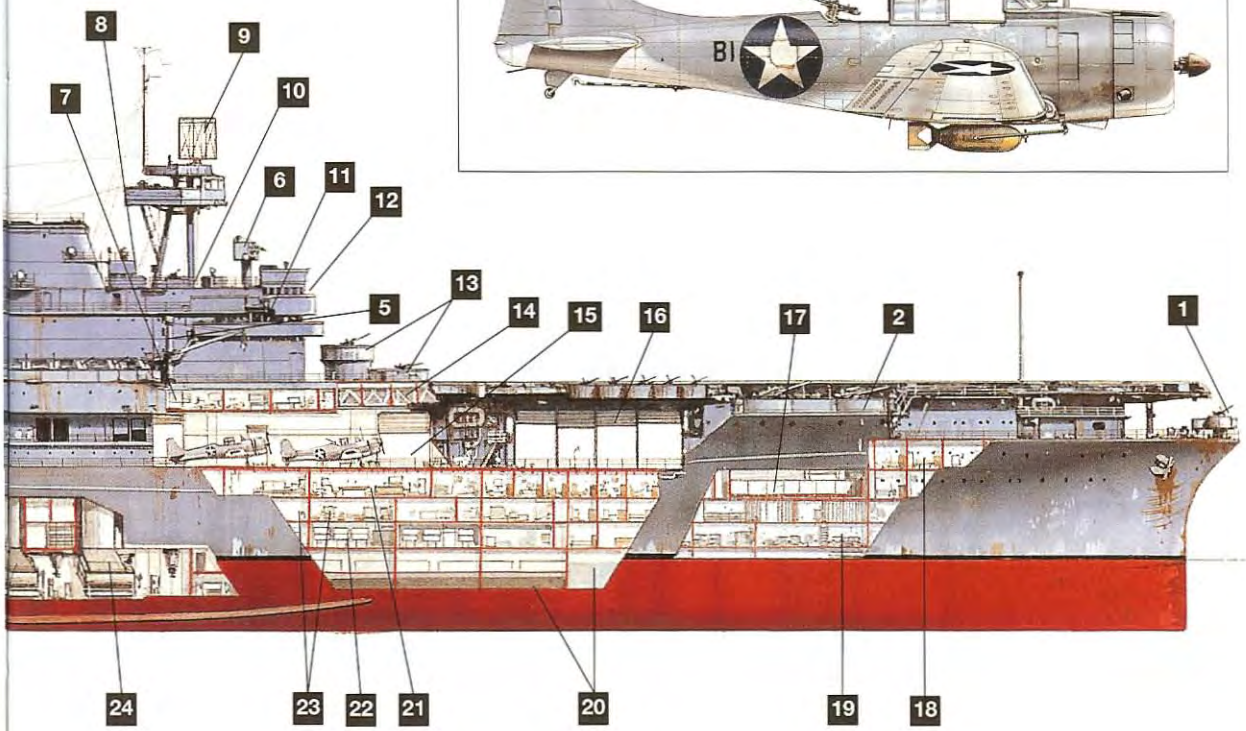


1: Bofors quad 40mm gun mount

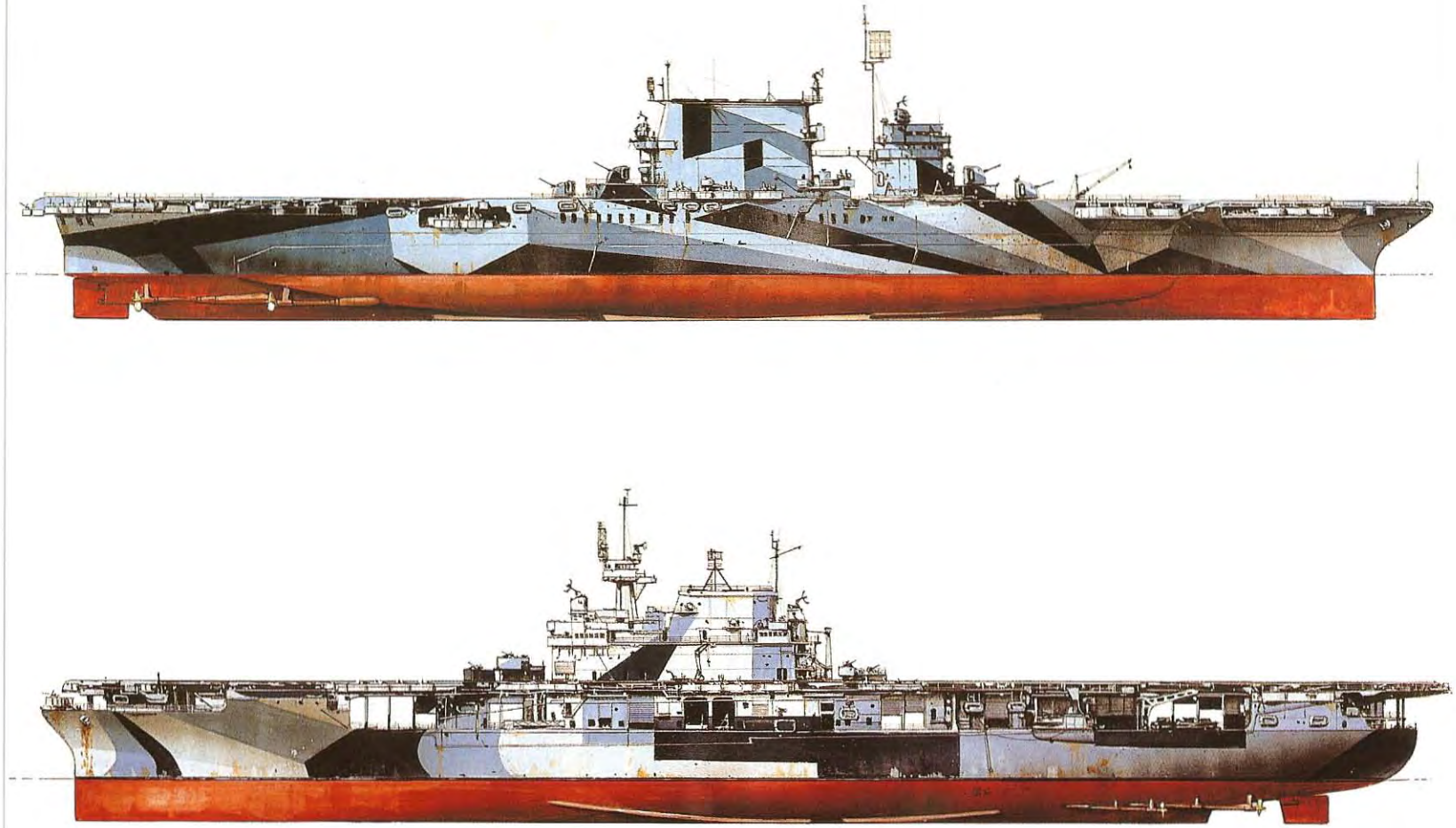


2: Dauntless SBD-3 from VB-6

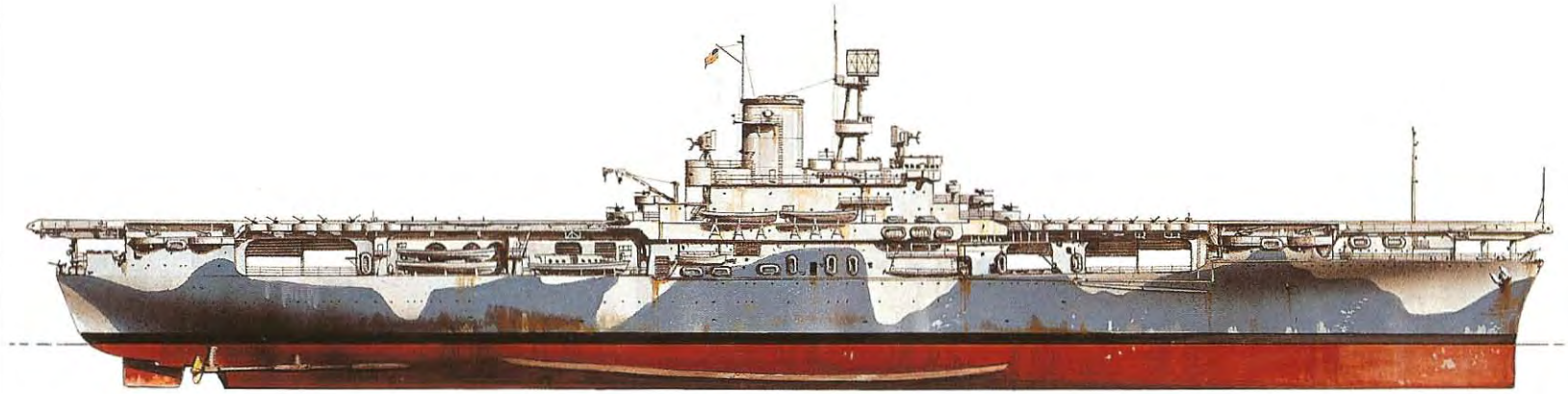




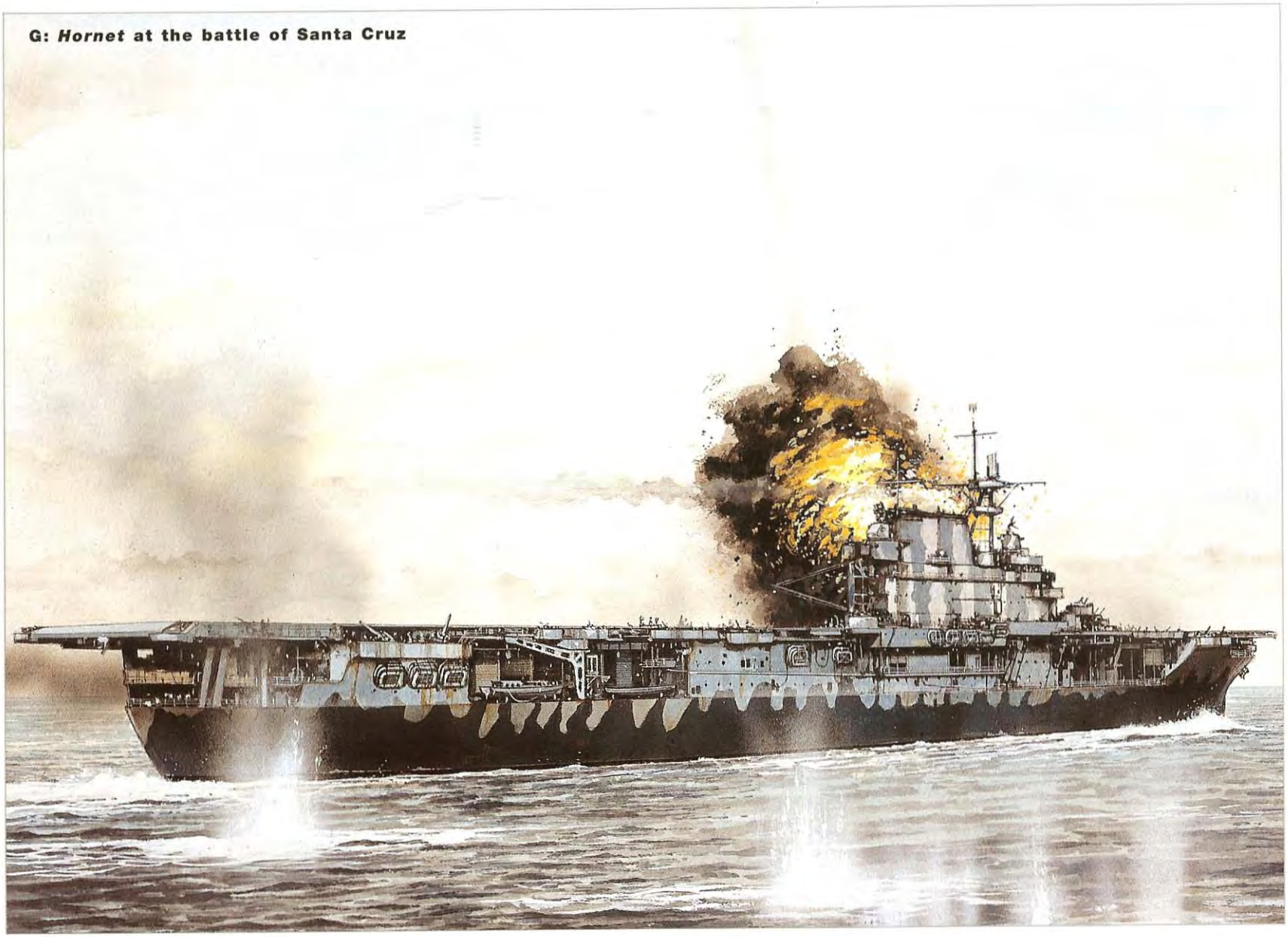
E: Late-war configurations



F: The unique carriers



G: *Hornet* at the battle of Santa Cruz



and June, *Ranger* ferried P-40 fighter aircraft to Africa. The highlight of the ship's combat career was undoubtedly in November 1942 when *Ranger* was the sole fleet carrier assigned to participate in the North African landings. During this operation, *Ranger*'s aircraft attacked Vichy French naval and ground targets including the incomplete battleship *Jean Bart* at Casablanca. Another P-40 ferry run was conducted in January 1943. In August, at British request, *Ranger* joined the Royal Navy's Home Fleet and was assigned to watch for possible movement of German heavy ships operating from Norway. In October 1943, *Ranger* conducted her last combat operation of the war when her aircraft conducted air strikes against German shipping in the area of Bodø, Norway. Upon detaching from the Home Fleet in November, *Ranger* returned to the US and assumed the role of a training carrier. Once it was decided not to modernize the ship, she became a night training carrier and was moved into the Pacific, where she continued her training duties until August 1946. She was sold for scrap in 1947.

USS *RANGER*

Displacement: 14,500 tons
Dimensions:
- Length 769ft
- Beam 80ft
- Draft 20ft

Maximum speed: 29.5kt
Radius: 9.960nm
Crew: 216 officers, 2,245 enlisted personnel (including air group)

Assessment

Of the seven prewar carriers, only *Ranger* saw no action in the Pacific. This alone speaks volumes on how she was viewed within the US Navy. Among the seven, she was the slowest and had the least adequate degree of protection and compartmentation. Her small size meant that she could not operate comfortably in common Pacific swells and was unable to operate aircraft in even moderate seas. With the experimental *Langley* providing the only carrier experience, it is clear that *Ranger*'s design was a false step. The experience gained in her construction at least meant that the same mistakes would not be made in the next class of carrier.

This view shows *Yorktown* just after commissioning. Note the roller curtains along the port side of the hanger deck and the large island. The Mark 33 Directors are located above the bridge and aft of the stack.

THE *YORKTOWN* CLASS (*YORKTOWN* (CV-5), *ENTERPRISE* (CV-6), AND *HORNET* (CV-8))

Design and construction

The *Yorktown* class was the first class of modern US carriers and the first designed with the benefit of fleet experience. The basic design proved so successful that it proved the basis for the even more successful *Essex* class. The genesis of the design came in the aftermath of what was generally viewed as the failed *Ranger* design. With the remaining carrier Treaty tonnage, it was decided to build two larger ships of some 20,000 tons rather than another *Ranger*-sized design. This would permit the correction of *Ranger*'s most glaring weakness – lack of protection.

A carrier of some 20,000 tons had sufficient size to allow a real degree of protection against torpedo attack, a primary design feature in the *Yorktown* class. A 4in side armor belt was fitted over the machinery spaces, magazines, and gasoline storage tanks. The bottom 4ft of the belt below the waterline was tapered to 2.5in. Vertical protection was limited to 1.5in of armor over the machinery spaces. The ends of the machinery spaces were protected by a 4in armor bulkhead. Underwater protection was further enhanced by a side protective system that extended the same length as the side armor. This system consisted of three tanks intended to absorb the shock of any torpedo; the inner tank was a void and the outer two were filled with liquids. The entire length of the ship was double-bottomed.

Many other design features were carried over from *Ranger*. The main deck was the hangar deck with the unarmored flight deck being built of light steel. Much of the hangar deck could be opened up by the use of large roller curtains. These were opened to allow aircraft to warm up prior to launch and closed to accommodate weather conditions or tactical requirements. The largest island yet fitted on a US carrier was included and provided room for conning and navigation, aircraft control, and fire control. A large stack was designed into the island, making this the first US carrier with a combined island/stack.

This fine October 1941 view of *Hornet* was taken around the time of her commissioning and shows her before radars and armament were fitted. The modifications to her bridge area are evident compared to her sister ships.

Enterprise **shown maneuvering at high speed during the battle of Midway. During this engagement, *Enterprise*'s dive bombers sank three of the four Japanese fleet carriers present.**

Nine boilers and four sets of geared turbines were required to produce the 32.5-knot top speed design requirement. All of the boilers were located forward of the two engine rooms. The close location of the two engine rooms was not desirable, but was later rectified in the *Essex* class.

The first two ships of the class, *Yorktown* and *Enterprise*, were commissioned in 1937 and 1938 respectively. The third ship of the class, *Hornet*, did not enter service until 1941. When the Washington Treaty expired, and additional carrier construction was authorized, the best design available was the *Yorktown* class. Instead of being delayed waiting for a new design, *Hornet* was built to a slightly modified *Yorktown* class design. As such, she was the last carrier affected by treaty limitations. The major difference in construction was the substitution of the Mark 37 Director for the Mark 33.

The *Yorktown* class was designed to operate 90 aircraft, including 84 combat aircraft and six utility aircraft, but in service somewhat fewer were invariably carried. To support the large air group, all three ships had three elevators and two deck catapults fitted. Another catapult was fitted flush to the hangar deck immediately aft of the forward elevator. The hangar deck catapult was intended to permit launching of scout aircraft even when the flight deck was occupied by preparations for a full-deck strike.

Yorktown **in dry dock in Pearl Harbor undergoing repairs following the battle of the Coral Sea. Note the 20mm guns placed on the bow.**

Armament

The *Yorktown* class was one of the first equipped with the new 5in/38 dual-purpose guns. Controlled by a pair of Mark 33 Directors mounted on the island, these guns provided long-range antiaircraft protection. For intermediate and close-in protection, four 1.1in quadruple mounts were placed fore and aft of the island and a total of 24 .50-cal. machine guns were fitted on the gallery deck.

Service modifications

Prior to the war, these ships were not extensively modified as they already carried what was believed to be an adequate antiaircraft suite, and in any event they could not be spared from service for an extensive refit. However, during wartime, many modifications were carried out whenever conditions permitted work to be done.

Under wartime conditions, the hangar deck catapults were seldom used. *Enterprise*'s and *Hornet*'s

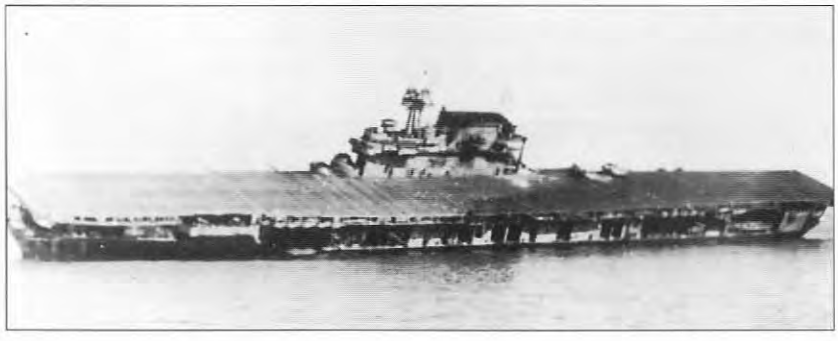
were removed in June 1942 while *Yorktown* was sunk with hers onboard. Another feature never used under wartime conditions was the forward set of arresting wires. Accordingly, these were removed from *Enterprise*. Prior to the war, the crash barrier was also modified from the old wooden type to a wire-supported canvas sling type that, when used, would not cause as much damage to an aircraft.

Most modifications concerned the antiaircraft battery. Even before the war, the general policy was to substitute twin 40mm mounts for the 1.1in mounts and 20mm for the .50-cal. machine guns. However, shortages precluded this from taking place until after the war had begun. By June 1942, all three ships had received 20mm guns – 24 in *Hornet* and *Yorktown* and 32 in *Enterprise*. *Yorktown* and *Hornet* were lost before their 1.1in mounts could be removed. In August 1942, more 20mm were added: 38 in *Enterprise* and 32 in *Hornet*. *Hornet* was lost before any further modifications were made. During repairs to battle damage to *Enterprise* in November 1942, four quadruple 40mm mounts replaced the 1.1in mounts located around the island and the number of 20mm guns was increased to 46.

Yorktown on fire after the attack by _Hiryu_'s dive bombers as seen from heavy cruiser USS _Astoria_. The F4F-4s spotted forward are from _Yorktown_'s combat air patrol. _Yorktown_ was painted in a Measure 12 scheme when lost.

Enterprise's first major refit and modernization took place beginning in July 1943. She emerged with a greatly modified antiaircraft battery of six quadruple 40mm mounts, eight twin 40mm mounts and 48 20mm guns. Two experimental 20mm mounts, a double and a triple, were briefly embarked but were quickly replaced by single mounts. Two Mark 37 Directors replaced the old Mark 33s and the radar suite was modernized. The first facilities to handle night fighters were fitted and a new Combat Information Center was built in the island. The ship's gasoline storage tanks were modified to enhance survivability. New, more powerful catapults were provided. With the addition of new blisters for increased stability and enhanced underwater protection, *Enterprise*'s fully loaded condition was now 32,060 tons.

Enterprise's last refit and modernization occurred in 1945 following her last wartime damage. The advent of the kamikaze had demonstrated the uselessness of the light 20mm guns and it was considered necessary to mount as many 40mm guns as possible. *Enterprise* emerged with a battery of 54 40mm guns (11 quadruple and five twin). To compensate, the twin 40mm on the bow was removed and the number of 20mm mounts reduced to 16 twins. Additional directors were also provided in



Following the attack by _Hiryu_'s torpedo aircraft, _Yorktown_'s list eventually reached 26 degrees and her captain ordered her to be abandoned. Two additional submarine-launched torpedoes finally resulted in her destruction.

***Enterprise* under attack at Santa Cruz. Hit by two bombs, 44 of her crew were killed and 75 wounded.**

the form of a Mark 57 on each quadrant for the 5in/38 and four Mark 63s for the quadruple 40mms. Also, a total of 11 Mark 51 optical lead-computing directors were provided.

Another important wartime improvement was the addition of radar. One of the six prototype CXAM radars was fitted in 1940 to *Yorktown*. *Enterprise* received the improved CXAM-1 and *Hornet* the smaller SC radar. The SC proved disappointing in service, so during the summer of 1942 Hornet received the CXAM salvaged from the sunken battleship *California*. Only *Enterprise* survived long enough to receive a full radar upgrade. Late in 1942, an SC-2 was mounted on the stack, and later an SK radar was shipped for long-range air search together with an SM height-finder.

Operational histories

USS *Yorktown*

The lead ship of the class was laid down in May 1934, launched in April 1936, and commissioned into service in September 1937. *Yorktown* participated in the 1939 Fleet Problem in Caribbean and the 1940 Fleet Problem conducted in the Pacific, after which she remained in Hawaiian waters. In April 1941, *Yorktown* departed Pearl Harbor to reinforce the Atlantic Fleet. There she conducted several neutrality patrols before US entry into the war. At the start of the war only three carriers remained in the Pacific to face the Japanese onslaught, so it was quickly decided to move *Yorktown* back into the Pacific.

Yorktown's first combat action came on February 1, 1942 during raids on Japanese facilities in the Marshall and Gilbert Islands. Damage to the Japanese was light. On February 14, *Yorktown* headed south from Pearl Harbor for the Coral Sea. Together with *Lexington*, 52 Yorktown aircraft attacked Japanese shipping at Lae and Salamaua on March 10, bagging a disappointing three transports. Later, in response to new Japanese landings, this time on Tulagi in the Solomons, *Yorktown* launched 40 strike aircraft against Japanese shipping on May 4. This time *Yorktown*'s aircraft sank a destroyer and three small minesweepers. Meanwhile, other Imperial Navy forces were moving towards Port Moresby, covered by two modern carriers, *Shokaku* and *Zuikaku*. On May 8, the battle was joined between the two carrier forces. *Yorktown*'s dive bombers scored two hits on *Shokaku*, but she survived. In turn, *Yorktown* was attacked by Japanese torpedo and dive bombers. All torpedoes were evaded by skillful maneuvering, but a single bomb hit the ship, penetrating the flight deck before exploding and killing or wounding 66 of the crew.

***Enterprise* at Noumea in November 1942 following the climactic Japanese attempt to recapture Guadalcanal. It was during this period that *Enterprise* was the sole remaining operational carrier in the Pacific and played a vital role in defeating the Japanese onslaught.**

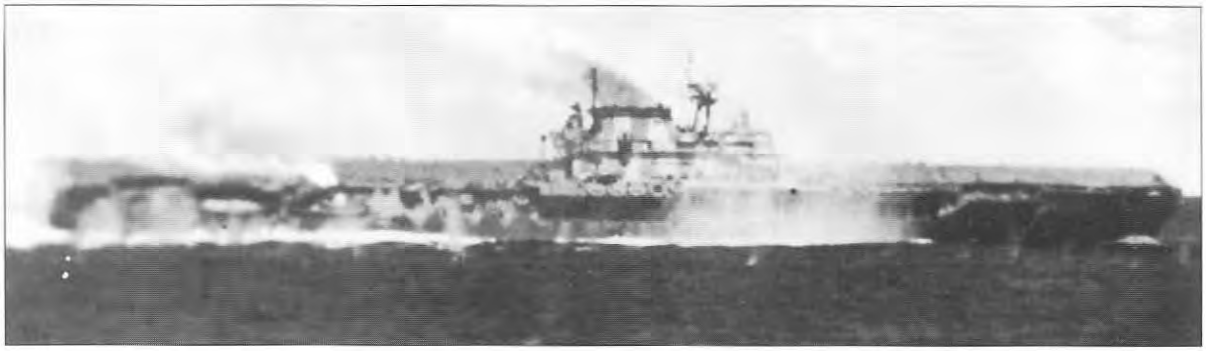
It was estimated that three months were required to repair the damage, but the ship was patched up in a remarkable three days at Pearl Harbor and quickly put to sea to join with sister ships *Enterprise* and *Hornet* northeast of Midway for the most important battle of the Pacific War. June 4 saw the Japanese open the battle with an attack on the airfield on Midway Island. The Japanese carriers were located first, allowing all three US carriers to launch a full deck-load strike. *Yorktown*'s contribution was a first wave of 35 aircraft followed by another 23. Her dive bombers destroyed the carrier *Soryu* and two other carriers were destroyed by *Enterprise* aircraft. The last remaining Japanese carrier, *Hiryu*, immediately launched an 18 dive bomber strike that struck *Yorktown*. Three hits were scored, one on the flight deck, another in the lower part of the stack, and a third that penetrated the forward elevator to explode on the fourth deck. *Yorktown* went temporarily dead in the water, but 20 knots had been attained by the time a second wave of *Hiryu* torpedo bombers arrived. This time, *Yorktown* was hit by two torpedoes on her port side. Again the ship went dead in the water and soon was listing heavily. Salvage efforts were on the verge of paying off when submarine I-168 put two more torpedoes into *Yorktown*. This final damage proved fatal and the ship finally sank on June 7.

USS *Enterprise*

This ship was the most decorated in US naval history, with a Presidential Unit Citation, a Navy Unit Commendation, and 20 battle stars for her Second World War service. *Enterprise* was launched in October 1936, commissioned in May 1938, and assigned to the Pacific Fleet. When the Japanese struck Pearl Harbor, *Enterprise* had almost returned to port after delivering fighter aircraft to Wake Island, thus barely evading almost certain destruction. Her first real combat came in February 1, 1942 when she launched a full-deck strike of 67 aircraft against Japanese facilities on Kwajalein in the Marshall Islands. This was followed by raids on February 24 against Wake and March 3 against Marcus Island. In April, *Enterprise* provided air cover for *Hornet* during the Doolittle raid against the Japanese homeland. Ordered south to reinforce US forces in the South Pacific, *Enterprise* barely missed the battle of the Coral Sea.

After her early war heroics, *Enterprise* remained active up until the end of the war, never missing a major engagement. Here she is shown under attack by Japanese aircraft on June 19, 1944 during the battle of the Philippine Sea.

June 1942 found *Enterprise* laying in wait for the Japanese invasion force headed for Midway Island. During the battle, *Enterprise*'s air group played a pivotal role in the most decisive engagement of



***Hornet* maneuvering under attack from Japanese carrier aircraft on October 26, 1942. She is already on fire from bomb damage.**

the Pacific War. Dive bombers from *Enterprise* were responsible for sinking the Japanese carriers *Akagi* and *Kaga*, and shared in the destruction of *Hiryu*. In return, *Enterprise* was undamaged. Action now shifted to the South Pacific where the US Navy had landed on the key island of Guadalcanal. In the war's third carrier action, the battle of the Eastern Solomons in August 1942, *Enterprise* came under attack by dive bombers, suffering three bomb hits and four near misses. Despite the damage, she was able to return to Pearl Harbor under her own power and had been repaired in time by the next carrier engagement, the battle of Santa Cruz in October. *Enterprise* was again damaged, this time by two bombs; in return her small strike of 20 aircraft was ineffective. In the aftermath of Santa Cruz, *Enterprise* was the only operational carrier in the Pacific. Repairs to her latest battle damage were underway at Noumea, New Caledonia, when the final Japanese effort to recapture Guadalcanal kicked off. Again, *Enterprise*'s air group was instrumental in victory as it shared in the destruction of the first Japanese battleship sunk during the war and several transports attempting to land men and supplies on the island. After remaining in the Solomons for the first three months of 1943, *Enterprise* returned to Pearl Harbor in May to receive the first Presidential Unit Citation awarded to an aircraft carrier during the war. In July, she returned to the US for her first overhaul.

The arrival of the newer *Essex* class fleet carriers meant that *Enterprise* no longer played a leading role. In November 1943, she had returned to service to cover the Gilbert Islands operation in the Central Pacific. In January 1944, she participated in operations against the Marshall Islands. In February 1944, *Enterprise* was part of the largest US carrier strike to date, the destruction of Japanese naval and air forces at Truk atoll in the Caroline Islands. By this time, *Enterprise* had assumed the duties of night carrier, employing both fighter and bomber aircraft in night missions. In March, *Enterprise* hit the Palau Islands; in April, she provided support to landings in Hollandia, New Guinea, and revisited Truk.

US landings on Saipan in the Mariana Islands in June 1944 prompted the Imperial Navy's reconstituted carrier force to give battle in what became history's largest carrier clash. *Enterprise*'s air group took part in the decisive destruction of the attacking Japanese carrier air groups. In October, she participated in the battle for Leyte Gulf, launching several strikes against Japanese surface units threatening the US beachhead on Leyte. After a short pause at Pearl Harbor, she returned to service with an entire air wing dedicated to night operations. In February 1945, she took part in the first carrier strikes against the Japanese homeland and

***Hornet* lies dead in the water and listing. Attempts to tow the damaged carrier clear of the battle area were fruitless and the ship had to be scuttled. *Hornet* was the last fleet carrier lost during the war.**

later that month covered the landings on Iwo Jima. In March, the US carrier task force returned to the Japanese home islands with *Enterprise* providing night air defense. Slight damage on March 18 required a return to the fleet anchorage at Ulithi for repairs before returning to action to cover the April 1945 landings on Okinawa. Kamikaze damage on April 11 required another return to Ulithi.

Enterprise's final damage of the war occurred on May 14 when a kamikaze struck the flight deck in the area of the forward elevator. A bomb penetrated to the third deck before it exploded, blowing the elevator off the ship and causing a large fire on the hangar deck. Following her final refit in 1945, *Enterprise* never returned to combat. She was employed in returning US troops from overseas after the war's end. Shamefully, plans to turn this symbol of the US Navy's war in the Pacific into a memorial failed and *Enterprise* was sold for scrap in 1958.

USS *Hornet*

With a service life of only one year, *Hornet* did not have the illustrious service history of her sister ships. She was commissioned in October 1941 as US entry into the war was looming. Beginning the war in the Atlantic Fleet, *Hornet* was deployed to the Pacific in March 1942 where she immediately loaded 16 B-25 bombers for her most famous mission, the launching of Colonel Jimmy Doolittle's raiders against the Japanese homeland in April 1942. After missing the battle of the Coral Sea, *Hornet* was present at Midway, but during the battle her air group put in a dismal performance. A full-deck strike of 59 aircraft on June 4 resulted in no damage to the Japanese with her dive bombers unable to find their targets and her torpedo squadron being annihilated by Japanese fighters. Sent to the South Pacific, on October 26, *Hornet* and *Enterprise* faced a Japanese force of four carriers in the battle of Santa Cruz. While *Hornet*'s two strikes with a total of 55 aircraft succeeded in damaging *Shokaku*, *Hornet* was subjected to the most well-coordinated Japanese carrier air attack of the Pacific War. Attacked simultaneously by torpedo and bomber aircraft, *Hornet* was struck by two torpedoes, three bombs and two aircraft that deliberately crashed into the ship. One of the torpedo hits flooded the forward engine room and caused the loss of all power. Later in the day, *Hornet* was hit by another torpedo (this one flooding the aft engine room) and another two bombs but still stayed afloat. After the crew had abandoned ship, two destroyers attempted to scuttle the ship with another nine torpedoes and almost 400 rounds of

5in fire, but *Hornet* refused to go under. Finally, Japanese destroyers put another four torpedoes into the blazing hulk before she sank early on October 27.

USS *YORKTOWN*

Displacement: 19,576 tons
Dimensions:
- Length 810ft (*Hornet* 825ft)
- Beam 110ft (*Hornet* 114ft)
- Draft 25ft

Maximum speed: 33kt
Radius: 11,200nm at 15kt
Crew (1941): 227 officers, 1,990 enlisted personnel (including air group)

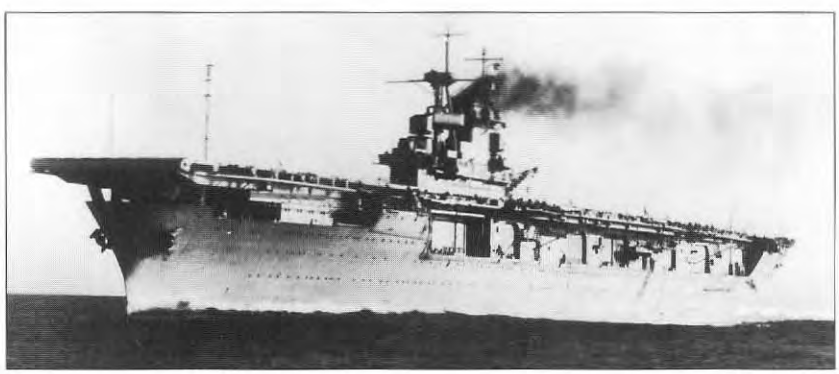
Assessment

The class showed an amazing ability to sustain damage, far beyond its design expectations. It also proved remarkably adaptive, taking continually larger aircraft as the war progressed while still remaining capable of operating a large air group. *Enterprise* also took a number of electronic upgrades. These ships proved to be the backbone of the US Navy during the days when it was hard-pressed to counter Japanese expansion. Until the introduction of the *Essex* class, they provided the bulk of the US Navy's carrier air power. The *Yorktown* class was undoubtedly one of the most successful and influential carrier designs by any navy.

THE *WASP* (CV-7)

Design and construction

Wasp's unique design was driven solely by the desire to use the remaining 14,700 tons of the US Navy's treaty carrier allocation. With less than 15,000 tons, it was impossible to build a repeat of the *Yorktown* class, but designers tried to fit many features of the larger ship into *Wasp*. However, what resulted was a slightly improved version of *Ranger* with all of the major shortcomings of the earlier design. Several unique design features were used on *Wasp* to reduce its weight, such as an asymmetrical hull to compensate for the weight of the starboard side island without



***Wasp* in 1940 during sea trials prior to her commissioning.**

the use of ballast, and the fitting of the first deck-edge elevator, but the ship came in heavy at 15,400 tons. This resulted in stability problems in service.

Wasp's hull was shorter than *Ranger*'s by some 40 feet and possessed a slightly greater beam; consequently, an additional 21,000 shaft horsepower was provided, but the top speed of 29.5 knots was not entirely satisfactory. An unusual machinery arrangement was used with the forward and aft engine rooms separated by two sets of three-abreast boiler rooms. As on *Yorktown*, the boiler uptakes were vented out of a stack that was part of the starboard side island. The ship's key weakness was its light protection. Despite the fact that better torpedo compartmentation was provided compared to *Ranger*, no side belt was fitted, although provision was made to fit one in the event of war. The hangar deck was armored up to 1.25in and 3.5in bulkheads protected the after magazine and steering compartment.

This fine profile of *Wasp* shows her to be a combination of the designs for *Ranger* and the *Yorktown* class.

Wasp was also unique in that she had catapults installed in both ends of her hangar deck, not just forward as in *Yorktown*. Two flight deck catapults were also installed. In addition to the two deck elevators, a deck-edge elevator was fitted on the port side of the forward hangar bay. This T-shaped platform could be folded up for storage. Its success made it a standard design feature in subsequent fleet carriers. As designed, an air group of 72 aircraft was envisioned. Initially, as with *Ranger*, no provision was made for embarking torpedo aircraft. However in 1942, just before her loss, a small torpedo squadron was embarked. When sunk, *Wasp* embarked an air group of 32 fighters, 28 dive bombers, and ten torpedo planes.

Armament

Wasp was armed much like the preceding *Yorktown* class. Eight 5in/38 guns were arranged in pairs on the port and starboard bow and quarter. Four 1.1in quad mounts were fitted forward and aft of the island. Close-in air defense was provided by water-cooled .50-cal. machine guns arranged on the gallery deck around the flight deck.

***Wasp* shown in March 1942 in her Measure 12 (modified) scheme; she would retain this camouflage until her loss. The aircraft spotted forward is a Grumman J2F utility aircraft.**

Service modifications

During her short service life, little was done to *Wasp* other than to enhance her antiaircraft protection. By January 1942, this had been increased by 34 20mm guns with all but six of the machine guns having been removed. The 5in battery and the 1.1in mounts were retained and their splinter protection improved. As with other carriers, it was intended to rearm her with 40mm and 20mm guns, but only a single quadruple 40mm mount was fitted before her loss. During a January 1942 refit, a CXAM-1 radar was fitted.

Operational history

The US Navy's seventh carrier was commissioned in April 1940 and assigned to the Atlantic Fleet. In August 1941, she ferried P-40s to Iceland. After the US entry into the war, she was used to escort high-value convoys from her base in Maine. In March 1942, *Wasp* and the new battleship *Washington* were sent to join the Home Fleet to permit the Royal Navy to commit Home Fleet units to the invasion of Madagascar in the Indian Ocean. The highlight of *Wasp*'s brief wartime service came in April and May of 1942 when she was employed in the ferrying of badly needed Spitfire fighters to the hard-pressed British island of Malta in the central Mediterranean. On the first occasion 47 Spitfires were delivered, but these aircraft were quickly destroyed by German attacks so a repeat performance was arranged. This time another 47 Spitfires were delivered.

By late May, the scope of the Japanese threat in the Pacific dictated that *Wasp* be transferred from the Atlantic Fleet. Transiting the Panama Canal in early June, she arrived too late for Midway, but was part of the covering force for the landings on Guadalcanal in August 1942. *Wasp* remained in the Solomons area throughout August but missed the carrier battle of the Eastern Solomons on August 24 when she was caught refueling to the south. Her brief service in the Pacific came to a close the following month during an operation to escort the movement of the 7th Marine Regiment to Guadalcanal. On September 15,

Not a common sight – a Royal Air Force Spitfire fighter takes off from a US Navy carrier. Note the size of the two massive Mark 33 Directors on *Wasp*'s island.

submarine I-19 struck the ship with three torpedoes in the vicinity of the forward gas tanks and magazines while *Wasp* was refueling aircraft. Fires from gasoline explosions quickly engulfed the forward part of the ship and after only 35 minutes she was abandoned with the loss of 193 men. *Wasp* was the second fleet carrier to be lost to gasoline-induced fires, but her loss was useful in the sense that it caused extensive changes to the *Essex* class's gasoline storage system. No additional fleet carriers were lost to this cause for the remainder of the war.

USS *WASP*

Displacement: 14,700 tons
Dimensions:
- Length 749ft
- Beam 81ft
- Draft 20ft

Maximum speed: 29.5kt
Radius: 12,000nm at 15kt
Crew: 201 officers, 2,046 enlisted personnel (including air group) (Sep 42)

Assessment

Essentially a repeat *Ranger*, *Wasp*'s key weakness was a lack of protection. This was exposed at the time of her sinking, but in all fairness, probably no US carrier could have escaped a similar gasoline-fed conflagration.

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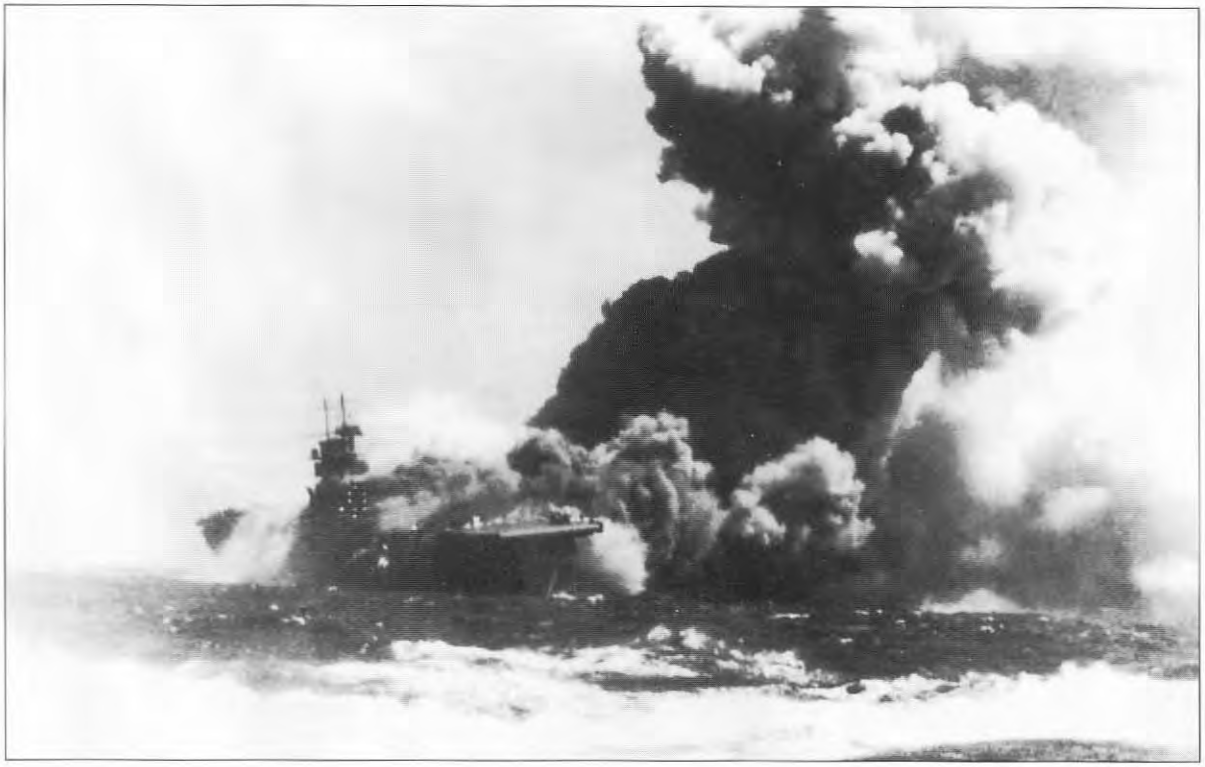
COLOR PLATE COMMENTARY



***Wasp* burning heavily after being torpedoed by submarine I-19. Once the ship's fuel storage system had failed, the fire could not be contained. Wasp was the last US fleet carrier lost during the war because of a fuel-induced fire.**

COLOR SCHEMES

Prior to the war, US Navy carriers were painted in a color scheme of standard navy gray with the top of the stack painted gloss black, all decks in standard dark deck gray, and the wood flight decks left in their natural Douglas Fir color. In September 1937, the Bureau of Construction and Repair issued a document on naval camouflage, *Handbook on Ship Camouflage*, that was to become the basis for a wide variety of camouflage schemes used on all US Navy ships during the war. The actual detailed instructions for the various schemes were issued later by the Bureau of Ships in a number of manuals.

During the war, US Navy prewar carriers were painted in the following schemes:

Measure 1. This scheme was employed during 1941 on *Lexington*, *Saratoga*, and *Enterprise*. It used Dark Gray 5-D on all vertical surfaces and all decks, with only the upper parts of masts left in white. Measure 1 was a low-visibility scheme intended to make surface and aerial observation more difficult.

Measure 4. This scheme was employed during 1941 on *Ranger* and *Wasp*. It used plain black paint on all vertical surfaces with Dark Gray 5-D on all decks. Wood decks were not darkened. Measure 4 was a low-visibility scheme intended to make daylight aerial observation more difficult.

Measure 5. This scheme entailed the addition of a painted bow wave in conjunction with Measure 1. This was intended to provide speed deception against surface observation. *Lexington* used this device in 1941.

Measure 11. This scheme was employed from September 1941 until June 1942 and was worn by *Lexington*, *Saratoga*, and *Enterprise*. This required that the entire ship, including the flight deck, be painted in Sea Blue 5-S. This replaced Measure 1 and was intended to act as an antiaircraft concealment scheme hindering aerial observation under all conditions.

Measure 12. This scheme was employed from September 1941 until late 1942/early 1943 and was worn by all prewar carriers except *Saratoga* and *Enterprise*. It was a graded scheme using Sea Blue 5-S from the waterline to the hangar deck level, Ocean Gray 5-O on all other vertical surfaces, and Haze Gray 5-H used on all masts. Decks were painted in Deck Blue 20-B. *Ranger*, *Wasp*, and *Hornet* were painted in Measure 12 (modified), which applied the Sea Blue in a pattern that varied on each ship. Measure 12 was considered to be effective in its purpose of providing concealment against both surface and aerial observation while also providing some course and range deception.

Measure 21. This scheme was employed from June 1942 until the end of the war and was used by *Saratoga* and *Enterprise*. It was a replacement for Measure 11 after feedback indicated that a darker shade of blue-gray was

***Hornet* entering Pearl Harbor May 1942. Extensive wear on her Measure 12 scheme is evident.**

harder to see from the air. All vertical surfaces were painted in Navy Blue 5-N with all decks in Deck Blue 20-B.

Measure 22. This was an enhancement of Measure 12 and was worn by *Ranger*. This graded system was designed to provide antisubmarine and antiaircraft protection by making it difficult to judge the ship's position relative to the horizon. Navy Blue 5-N was applied on the lower portion of the hull parallel to the horizon with the upper portions being painted in Haze Gray 5-H. Decks were painted Deck Blue 20-B.

Measure 32. This was a dazzle camouflage intended to provide antisubmarine protection by causing target angle confusion at close ranges. Only *Saratoga* employed this camouflage pattern, using unique Design 11a with a mix of Pale Gray 5-P, Ocean Gray 5-O, and Dull Black 13. The deck remained in Deck Blue 20-B.

Measure 33. This was the refinement of other measures designed to give low-visibility antisubmarine protection. The colors used were similar to those in Measure 32. Many different designs were used. *Enterprise* received the unique 4a design, and *Ranger* was painted in Design 1a, both in 1944. Both had returned to a more subtle Measure 21 or 22 scheme by war's end.

A: USS *SARATOGA*

The top view shows *Saratoga* in her prewar configuration and colors. The battle cruiser hull is evident as is the enormous stack. Since she was nearly identical to *Lexington*, a large vertical stripe was painted on her stack to distinguish her.

The bottom view shows *Saratoga* in her mid-war configuration. She is now painted in a Measure 21 scheme to reduce her visibility from the air. The ship has undergone a dramatic transformation from her early war appearance. Gone are the large 8in gunhouses, replaced by 5in/38 dual turrets. *Saratoga* was the only prewar carrier to receive this weapon. The earlier 5in/25 mounts have been replaced by single 5in/38 mounts. Prewar machine guns have been replaced by a profusion of 20mm and 40mm guns, most located along the gallery deck. The island has been modified and is now topped with a Mark 37 Director with a Mark 4 radar; a second Mark 37 is located aft of the stack. Her radar fit now includes a CXAM-1 on the forward edge of the stack and an SC on a sponson aft of the stack. Less apparent is the reduction of the stack and the extension of the flight deck by some 20 feet.

B: THE *YORKTOWN*

The top view shows *Yorktown* in her prewar colors and configuration. Note the large combined island/stack with a large foremast and two Mark 33 Directors. A large crane is fitted aft of the stack for movement of aircraft and boats. The roller curtains in the forward and aft sections of the hangar bay are easily discerned.

In the bottom view, *Yorktown* is presented in her June 1942 appearance at the time of her loss. The ship is painted in a Measure 12 camouflage scheme. The CXAM radar added to her foremast is evident. Less obvious are the many 20mm guns and .50-cal. machine guns that now line her gallery deck. Two 20mm guns have been fitted on the bow in gun tubs.

C: *LEXINGTON* AT THE CORAL SEA

On May 8, 1942 *Lexington* came under attack by Japanese torpedo bombers. Eighteen were included in the Japanese attack group, and of these, 14 were directed to attack *Lexington*. Most of these survived *Lexington*'s poorly positioned Combat Air Patrol and Dauntless dive bombers employed on anti-torpedo plane patrol to launch their weapons. *Lexington*, despite the fact that she was the world's longest warship and her helm was slow to respond to steering orders, successfully evaded most of the torpedoes launched at her. However, at 1120, a group of four B5N2 attack planes from *Shokaku* scored. Two Type 91 torpedoes passed beneath *Lexington*, but two hit. The first hit forward on the port side, buckling the port gasoline storage tanks. This damage ultimately proved to be fatal as fumes leaked undetected from the tanks and later caused a series of catastrophic explosions. The second torpedo, which this scene depicts, hit on the port side, opposite the island. Torpedo damage flooded three firerooms, caused a large oil leak, and resulted in a 6–7 degree list.

At the time of her loss, *Lexington* was wearing a Measure 11 camouflage scheme. Her early war modifications can

clearly be seen by the absence of the 8in gunhouses, replaced by 1.1in mounts. Also evident is the platform built around the base of the island for 20mm guns; higher on the stack several machine guns remain. The ship carries a CXAM-1 radar forward on the stack and has been fitted with a small funnel cap.

D: USS *ENTERPRISE*, JUNE 1942, AT THE BATTLE OF MIDWAY

Enterprise bears the most famous name of any US carrier. This cutaway drawing depicts her during the battle of Midway during which she played a pivotal role.

The ship's main deck was actually the hangar deck. Everything below the hangar deck is called a deck; everything above is considered a level, including the areas within the island.

The flight deck had nine arresting wires aft and four crash barriers located amidships and further forward. *Enterprise* could carry approximately 80 aircraft; for the Midway operation she embarked 27 F4F Wildcats, 38 SBD Dauntlesses, and 14 TBD Devastators for a total of 79 aircraft.

The large island included the Navigation and Flag Bridges, spaces for the Air Control Officer, and the air and radar plots. Later, a full Combat Information Center was installed here. The island also supported two Mark 33 Directors and the CXAM-1 radar mounted on the large tripod mast. Forward and aft of the island are three 1.1in quad gun mounts.

The gallery deck was located one level down from the flight deck. Here the ship's captain and the embarked admiral had their in-port cabins. Also on this level were the ready rooms for the squadrons of the ship's air group. At the gallery deck level all around the flight deck was a walkway where easy access was possible to and from the flight deck and where many 20mm and .50-cal. machine guns were positioned.

The hangar deck provided the area where all major servicing and maintenance of aircraft was performed. All around the hangar deck were various spaces dedicated to the support of the different aircraft and their equipment. Three elevators connected the hangar deck with the flight deck. The hangar deck was open on both sides; a number of roller curtains provided protection from weather.

The lower decks contained the ship's vitals and most of the living areas for the crew. A number of large crew berthing areas were located on the second deck. Most of the crew slept in bunks stacked three high. Officer staterooms were located forward on the first, second, and third decks. Two to eight officers shared a room with bunks stacked two high. The officer's lounge and wardroom mess were located on the second deck. The third deck contained a number of supply storerooms, mess areas for warrant officers, chief petty officers, and the enlisted members of the crew, as well as the ship's sick bay. The fourth deck was primarily for storage, including general supply, ordnance, aviation, and refrigerated food storage. The lower decks contained the engineering spaces, including the boilers and the machinery required to drive the four propeller shafts.

Inset 1: Bofors quad 40mm gun mount.
Inset 2: Dauntless SBD-3 from VB-6.

E: LATE-WAR CONFIGURATIONS

The top view shows *Saratoga* in her final wartime configuration. The scheme is the striking Measure 32 with the Design 11a devised especially for *Saratoga* in an attempt to break up her massive silhouette. The differences from her mid-war appearance include an updated radar fit (with an SK in the pole mast aft of the island, an SM on the forward edge of the funnel, and an SC backup on the trailing edge of the stack). The antiaircraft fit has been upgraded again and now includes an amazing 23 quad and two twin 40mm mounts.

The bottom view is of *Enterprise* in her 1944 configuration. The camouflage scheme is the Measure 33 with the 4a design. Both *Enterprise* and *Saratoga* returned to a Measure 21 scheme in 1945 as the air threat became paramount. *Enterprise* has the same radar fit as *Saratoga*. Because of her smaller size, *Enterprise* was not able to carry 5in/38 dual turrets, but she does retain her eight single-mount 5in 38s. Efforts have been made to upgrade her antiaircraft to the more effective 40mm Bofors mounts. Four quads are located around the island and another two are located on sponsons on the hangar deck level. Several of the lighter dual 40mm mounts have been fitted forward.

F: THE UNIQUE CARRIERS

The top view is *Ranger* as she appeared during 1943 during her stint with the Royal Navy's Home Fleet. The camouflage pattern is Measure 22, in this case used to provide a degree of antisubmarine protection since she was operating in U-boat infested waters. *Ranger* is heavily armed with eight 5in guns (four of which are visible in this starboard side view), six 1.1in mounts (located forward and aft of the island, aft of the forward pair of 5in guns, and on the stern) and 46 20mm guns (many evident along the gallery deck and on the bow). The island supports the CXAM-1 radar and two Mark 33 Directors. Much of this equipment was removed when the ship was assigned to training duties.

The bottom view is *Wasp* shown in her final configuration in September 1942 before her loss. She is in a Measure 12 (modified) camouflage scheme that features sea blue on the hull, but not in the island. Unlike *Ranger*, the stack is part of the island, but both share an overall low standard of protection. Like *Ranger*, *Wasp* mounts a mix of 5in, 1.1in, and 20mm guns.

G: *HORNET* AT THE BATTLE OF SANTA CRUZ

This view is of *Hornet* as she appeared in October 1942 when she was sunk at the battle of Santa Cruz. The ship is in a Measure 12 (modified) camouflage scheme. There were no set patterns for this scheme and on *Hornet* the sea blue portions of the pattern cover almost the entire hull below the hangar deck level as well as several stripes on the island. The CXAM radar is evident on her island, as are the large Mark 37 Directors with Mark 4 radars. During the battle, *Hornet* came under attack by 20 *Shokaku* B5N2 torpedo bombers and 21 Aichi D3A1 dive bombers from *Zuikaku*. The moment depicted is the crash of one of *Zuikaku*'s dive bombers on *Hornet* when the aircraft caromed off the island and crashed on the flight deck. The 550lb aboard this aircraft did not explode, but three other bombs, two torpedoes, and another aircraft (this one a B5N2) did strike the ship, leading to her eventual loss.

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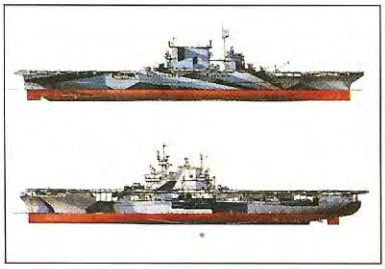

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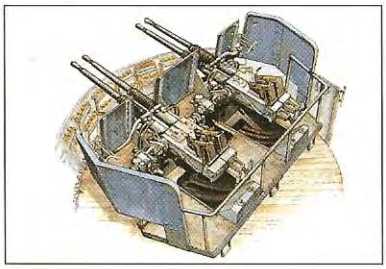

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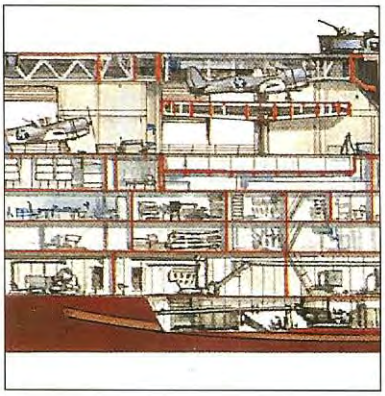

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